

MRT

MOBILE RADIO TECHNOLOGY®

Technical information for private, trunked and public safety networks.

JANUARY 2000



How business radio supports business delivery



New column, page 16
'Public safety 10-2'



An INTERTEC®/PRIMEDIA Publication

Vertex--For Business, Industry, and Public Safety.

Vertex Radio Communications, the land mobile division of Yaesu, has been at the forefront of high-tech engineering and quality manufacturing for over 40 years. Always keeping customer satisfaction as their goal, the Vertex line meets the ever-growing demands of private sector, public safety, and governmental organizations.

The Vertex full line of wireless radio equipment is compatible with commercial specifications worldwide, and includes a wide variety of portable, compact/mobile base stations, HF/SSB transceivers,

repeaters, and trunking systems.

Incorporating constant customer feedback with break-through design in synthesized radio communication technology has resulted in innovative products like the FTH-2070 32 Channel 5W Dual Band VHF/UHF Portable radio introduced in 1988. This unequaled radio gained immediate acceptance for its ability to link public safety organizations in time of crisis, and remains unique to Vertex today.

Now, with its expanded line--including the ultra-compact VX-10, 40 and 102 Channel

VHF/UHF Portables -- Vertex Radio Communications provides solutions to communication needs for business, industry, and public safety.

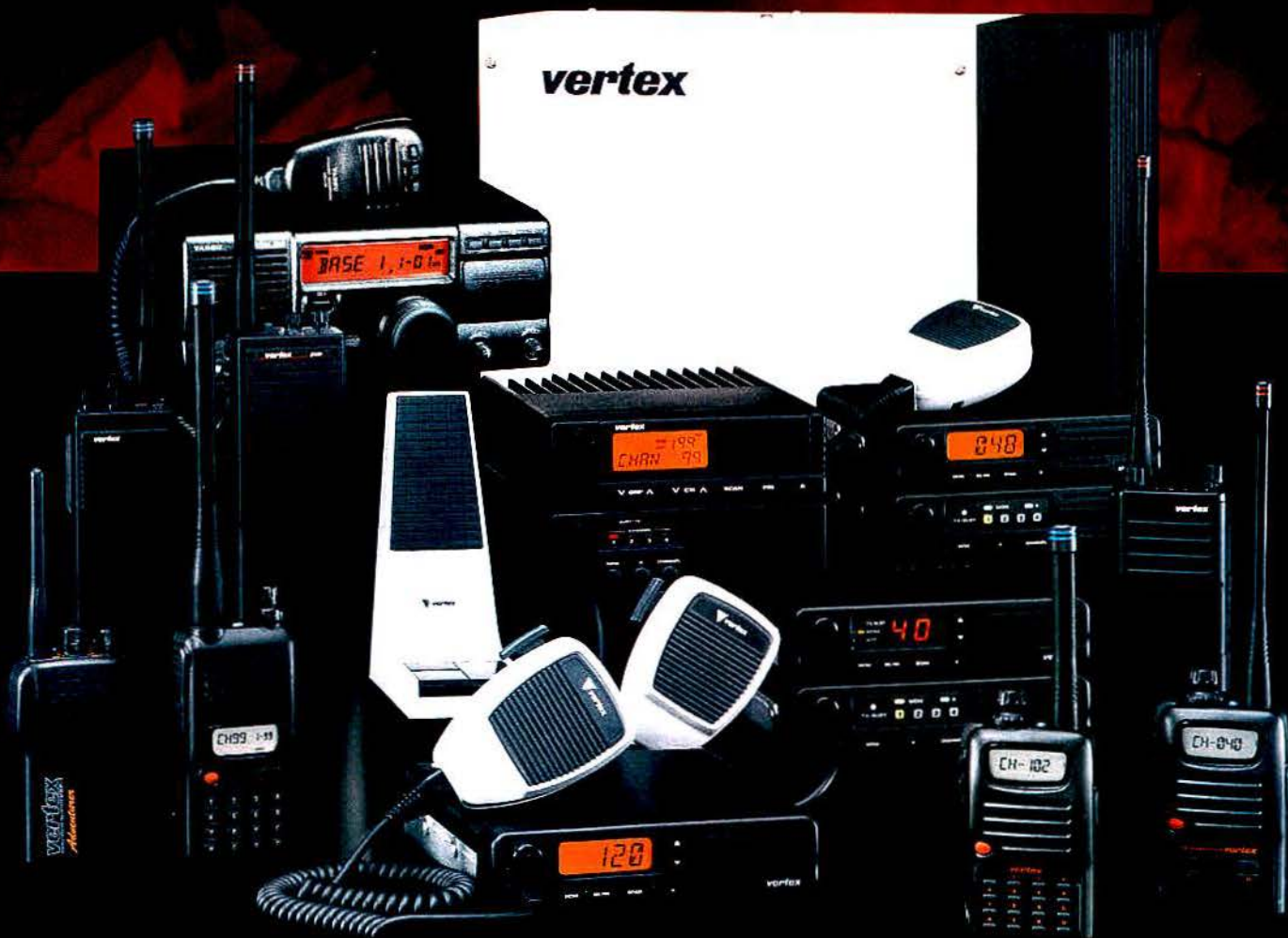
For more information about the complete line of Vertex Radio Communications products, see your authorized Vertex dealer, or call:

562-404-2700



vertex

RADIO COMMUNICATIONS
Land Mobile Division of Yaesu U.S.A.

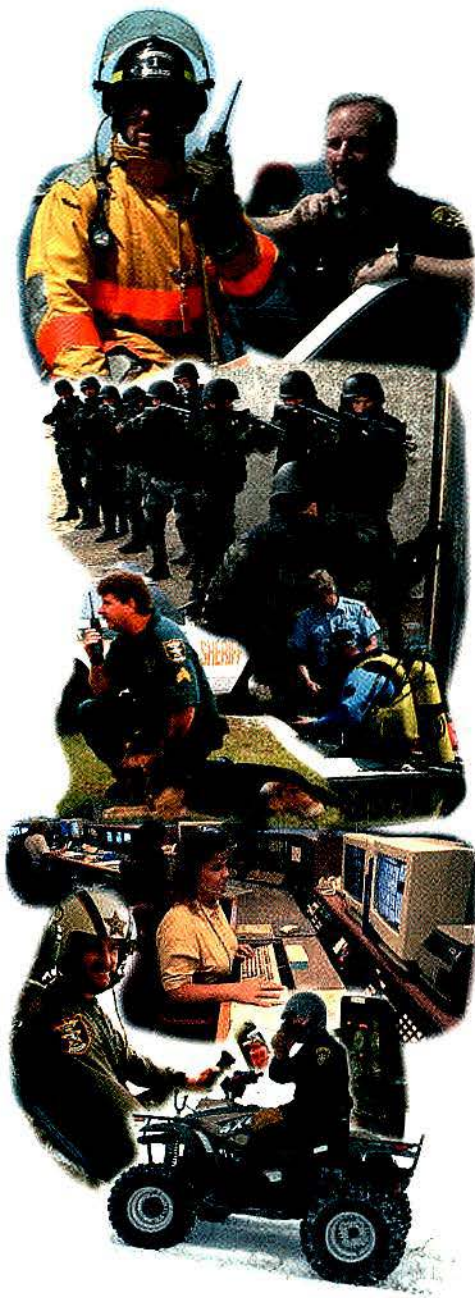


United States & Canada: Yaesu U.S.A., (562)404-2700

©1998 Yaesu USA. Specifications subject to change without notice

Circle (1) on Fast Fact Card

E.F. Johnson sends a clear signal about Project 25.



Our position is clear: Nobody knows better how public safety communications should work than the people who use it. These dedicated professionals have spent nearly a decade shaping their vision of how public safety communications will work in the future—the APCO-initiated Project 25 suite of standards. E.F. Johnson respects and applauds their efforts.

Our commitment is firm: E.F. Johnson Company is redoubling its commitment to Project 25. We were an original signatory to the Project 25 process. We were one of the first manufacturers to publicly demonstrate P25 Common Air Interface products. We're already the #2 manufacturer of Project 25 conventional products. And now, E.F. Johnson:

- Has just released System 3 trunking radios with 9600 bps P25 CAI.
- Will roll out additional Project 25 trunking terminals and infrastructure products.
- Supports Project 25 for the new 700 MHz band.

It's your choice: This is not the time for quick fixes or wireless technology that's unfamiliar and unproven in U.S. public safety applications. Public safety communications provide a lifeline that thousands of law enforcement officers, firefighters, and paramedics depend on every day.

The Project 25 standards are *your* standards, developed by you and your APCO colleagues. E.F. Johnson stands with you, remaining firmly committed to the goal of interoperable public safety communications across the U.S.—the goal of Project 25.



299 Johnson Avenue, Waseca, MN 56093

1-800-621-2945

Fax 507-835-8356 • www.efjohnson.com

Viking head/EFJohnson logo is a registered trademark of E.F. Johnson Company
© 2000 E.F. Johnson Company

Circle (4) on Fast Fact Card

MRT

MOBILE RADIO TECHNOLOGY®

January 2000



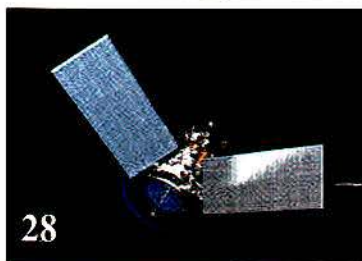
On the cover: Private wireless radio infrastructure is crucial to delivery industry leaders like FedEx. See the cover story on page 20. Cover design by Scott Dolash, art director. Photographs courtesy of FedEx, Memphis, TN.

FEATURES



24

- 20 Wireless@work:**
FedEx and land mobile
Thomas G. Dolan
Private wireless spectrum plays a crucial role in the operations infrastructure of one of the world's largest courier and business delivery services.



28

- 24 Predicting radio channel capacity**
Stephen E. Bartlett, B.S., M.S.
Capacity of a conventional two-way radio channel can be predicted using a voice message analogy similar to a data packet.



32

- 28 Satellite communications for public safety**
Tom D. Soumas Jr. and Dave Robertson
A southern application of satellite communications to rural emergency medical services communications demonstrates the advantages "sky-repeaters" offer to rural areas.
- 32 Product/services showcase**
Advertisers in this issue provide information on products and services.

DEPARTMENTS

- 4 Editorial**
Don Bishop
Millennium team
- 8 Calendar**
Editorial index
- 10 Editorial Forum**
Nikki Chandler
The day they took the radios
- 12 In the Public Interest**
Robert H. Schwaninger Jr.
You say you want a resolution?
- 16 Public safety: 10-2**
David O. Dunford
Setting up the basic dispatch
- 18 Technically Speaking**
Harold Kinley, C.E.T.
Transmission lines: unravelling the mystery
- 34 News**
ITA Conference focuses on spectrum management
- 38 Product focus: Headsets**
- 40 Products**
Readers' choice: Vertex Radio Communications
- 43 Classified**
- 56 Ad index**

Vol. 18, Issue 1, Mobile Radio Technology (ISSN 0745-7626) is published monthly by Intertec Publishing, 9800 Metcalf Ave., Overland Park, KS 66212-2215, and is mailed for free to qualified subscribers within the United States and Canada. Periodicals postage paid at Shawnee Mission, KS, and additional mailing offices. Canada Post Publications Mail (Canadian Distribution) Sales Agreement No. 0956309.

POSTMASTER: Send address changes to Mobile Radio Technology, P.O. Box 12960, Overland Park, KS 66282-2960.

SUBSCRIPTIONS: Non-qualified subscribers may subscribe at the following rates: United States and Canada: one-year: \$35. Qualified and non-qualified subscribers in all other countries: one-year: \$45 (surface mail); \$105 (air mail). Subscription information: P.O. Box 12960, Overland Park, KS. 66282-2960.

NEW from TX RX

UHF Broadband Collinear Antennas

With two patents granted for this design, our omnidirectional collinear array antennas add a new dimension to conventional base station antenna coverage. The true corporate-feed design improves pattern control, allowing higher gain from a shorter antenna.

Model Number	Gain	Freq. Range	Bandwidth	Vertical Beamwidth	Power Handling	Connector
101-68-10-X-01N	10 dBd \pm 0.5 dB	450-512 MHz	62 MHz	10°	1000 watts	N female
101-68-10-X-01	10 dBd \pm 0.5 dB	450-512 MHz	62 MHz	10°	1000 watts	7/16 DIN

"X" = downtilt = 0, 3, 6 (degrees)

**ONE MODEL COVERS ENTIRE
450-512 MHz BAND!**

TX RX Systems Inc.
8625 Industrial Pkwy.
Angola, NY 14006
Ph: 716-549-4700
Fax: 716-549-4772
Email: sales@txrx.com
Web Site: www.txrx.com



A member of Bird Technologies Group

Tx & Rx Multicouplers • Tower Mounted Preamplifiers • Signal Boosters • Duplexers • Cavity Filters • RF System Products

Circle (5) on Fast Fact Card

Millennium team

The technical supervisor for the Lenexa, KS, police department, **Dave Dunford**, becomes our public safety consultant and "10-2" columnist beginning with this issue. Dave also will serve as moderator for sessions in the public safety track at the March 22-24 International Wireless Communications Expo (IWCE).

I think Dave is a genius. Now, it's up to him to prove it to you.

(Does that give you anything to live up to, Dave?)

I became acquainted with Dave several years ago. His perspective on public safety communications and technology is refreshing and spot on.

Plus, he's one of these people who impress me with their hands-on electronics wizardry, such as **Harold Kinley** of the South Carolina Forestry Commission; **Bruce Marcus** of Marcus Communications & Electronics; **Don Koehler** of Communication Specialties; **Pat Buller** of Washington State Patrol; and **Bob Wiles** of Sunflower Radio Products.

Harold, we're happy to say, returns to a monthly schedule of "Technically Speaking" columns this year. And he's working on his third book. We were glad to have your column every other month in 1999, Harold, and we'll be twice as glad this year.

Bruce returns to IWCE with "Applying Marcus Magic to Site RF Design and Interference Issues Beyond Y2K." Mark your IWCE program with a "must see" for Bruce's session.

Don has been one of our more prolific contributing feature writers beginning way back in the '90s. (Remember the '90s?) Take advantage of the opportunity to meet Don, too, at IWCE. He'll be the moderator for sessions in the technology track. And I know he would welcome ideas for future technical articles that will help you in your business and your shop.

Pat steps up with technical articles, too, that have included some highly practical use-what-you-have and build-what-you-don't features that are popular with agencies that don't have much money to spend on new equipment. Pat will moderate sessions in the IWCE public safety track, so be sure to meet him while you're there.

Bob spends most of his time behind the scenes, though he once graced our cover. He's the hired intellect behind product designs that non-disclosure agreements keep him from talking about.

Jack Daniel, once *MRT's* west coast editor (remember when, Jack?), now an editorial adviser, takes to the dais at IWCE as moderator for sessions in the



regulatory track. Among his other talents, Jack is a master of specialty projects. He toils in the communications cauldron of Los Angeles where most ordinary radio systems have long since become impossible to configure because of spectrum shortage, geography, regulations or all three. That doesn't stop Jack. He's too creative and resourceful for that.

Bob Shapiro, another of our advisers, comes to the foreground at IWCE as the moderator of technology track sessions. We met him years ago through his work at an antenna manufacturer, though in recent years he has become known for his work with sites, networks and project management.

Although he spends most of his time with *RF Design* magazine these days, **Ernest Worthman**, technology editor, has a long involvement with IWCE dating from his time with *Communications* magazine. He will moderate sessions in the regulatory track.

Shouldering the conference organization duties again this year, **Jerry Whitaker**, program chairman, hosts "Industry Leaders Meet the Press" and sessions in the technology track.

IWCE opening session

The association between IWCE and *MRT* is so close that, when IWCE time is near, talking about one means talking about the other.

Robert H. Schwaninger Jr.'s "In the Public Interest" columns continue; in fact, it would be hard to imagine *MRT* without him as our regulatory consultant and columnist.

Robert will speak at IWCE's opening session, bringing his perspective as a telecommunications attorney, trade association official and businessman. What he won't bring is a rubber chicken. (He brought it last year. Few IWCE speakers have worked a rubber chicken into their presentation. Only Robert, come to think of it.)

Robert's column debuted seven years ago. Then, he was a maverick whose approach to law practice (put clients first; sue the government when necessary) made other telecommunications attorneys with a "go-along-to-get-along" attitude toward the government think was crazy, if not dangerous. Some told us we were crazy to publish him. Now, he's in demand as a writer, speaker and attorney. Many of his former critics have embraced his forthright approach. He'll tell it like it is, and you oughta be there to hear it.

Stephan Beckert not only makes his first IWCE appearance as a speaker at the opening session, he joins us as our newest editorial adviser. Stephan is director of dispatch and mobile data for the Strategis Group, which offers the most comprehensive market study and analysis of private radio of any research company. What's ahead for the industry? Responses gathered from the industry itself point the way.

Thanks

As we enter the new year, we want to thank our customers, contributors, advisers and co-workers who make the magazine possible.

Thank you, too, for reading. Visit us at www.mrtmag.com. Don't forget to tip your editors. And try the rubber chicken. We'll be here all year.

don_bishop@intertec.com

Don Bishop



...POWER ON WITH ASTRON

SWITCHING POWER SUPPLIES...

SPECIAL FEATURES:

- HIGH EFFICIENCY SWITCHING TECHNOLOGY SPECIFICALLY FILTERED FOR USE WITH COMMUNICATIONS EQUIPMENT, FOR ALL FREQUENCIES INCLUDING HF
- HEAVY DUTY DESIGN
- LOW PROFILE, LIGHT WEIGHT PACKAGE
- EMI FILTER
- MEETS FCC CLASS B

PROTECTION FEATURES:

- CURRENT LIMITING
- OVERVOLTAGE PROTECTION
- FUSE PROTECTION
- OVER TEMPERATURE SHUTDOWN

SPECIFICATIONS:

INPUT VOLTAGE: 115 VAC 50/60HZ
OR 220 VAC 50/60HZ
SWITCH SELECTABLE
OUTPUT VOLTAGE: 13.8VDC

AVAILABLE WITH THE FOLLOWING APPROVALS: UL, CUL, CE, TUV.



MODEL SS-10TK



MODEL SS-12IF



MODEL SS-18

DESKTOP SWITCHING POWER SUPPLIES

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SS-10	7	10	1 1/2 x 6 x 9	3.2
SS-12	10	12	1 1/2 x 6 x 9	3.4
SS-18	15	18	1 1/2 x 6 x 9	3.6
SS-25	20	25	2 1/4 x 7 x 9 1/2	4.2
SS-30	25	30	3 1/4 x 7 x 9 1/2	5.0



MODEL SS-25M

DESKTOP SWITCHING POWER SUPPLIES WITH VOLT AND AMP METERS

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SS-25M*	20	25	2 1/4 x 7 x 9 1/2	4.2
SS-30M*	25	30	3 1/4 x 7 x 9 1/2	5.0



MODEL SRM-30

RACKMOUNT SWITCHING POWER SUPPLIES

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25	20	25	3 1/2 x 19 x 9 1/2	6.5
SRM-30	25	30	3 1/2 x 19 x 9 1/2	7.0

WITH SEPARATE VOLT & AMP METERS

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25	20	25	3 1/2 x 19 x 9 1/2	6.5
SRM-30	25	30	3 1/2 x 19 x 9 1/2	7.0



MODEL SRM-30M-2

2 ea SWITCHING POWER SUPPLIES ON ONE RACK PANEL

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25A-2	20	25	3 1/2 x 19 x 9 1/2	10.5
SRM-30A-2	25	30	3 1/2 x 19 x 9 1/2	11.0

WITH SEPARATE VOLT & AMP METERS

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25M-2	20	25	3 1/2 x 19 x 9 1/2	10.5
SRM-30M-2	25	30	3 1/2 x 19 x 9 1/2	11.0



MODEL SS-12SM/GTX



MODEL SS-IDEFJ-98

CUSTOM POWER SUPPLIES FOR RADIOS BELOW

EF JOHNSON AVENGER GX-MC41
EF JOHNSON AVENGER GX-MC42
EF JOHNSON GT-ML81
EF JOHNSON GT-ML83
EF JOHNSON 9800 SERIES
GE MARC SERIES
GE MONOGRAM SERIES & MAXON SM-4000 SERIES
ICOM IC-F11020 & IC-F2020
KENWOOD TK760, 762, 840, 860, 940, 941
KENWOOD TK760H, 762H
MOTOROLA LOW POWER SM50, SM120, & GTX
MOTOROLA HIGH POWER SM50, SM120, & GTX
MOTOROLA RADIUS & GM 300
MOTOROLA RADIUS & GM 300
MOTOROLA RADIUS & GM 300
UNIDEN SMH1525, SMU4525
VERTEX — FTL-1011, FT-1011, FT-2011, FT-7011

NEW SWITCHING MODELS

SS-10GX, SS-12GX
SS-18GX
SS-12EFJ
SS-18EFJ
SS-10-EFJ-98, SS-12-EFJ-98, SS-18-EFJ-98
SS-12MC
SS-10MG, SS-12MG
SS-101F, SS-121F
SS-10TK
SS-12TK OR SS-18TK
SS-10SM/GTX
SS-10SM/GTX, SS-12SM/GTX, SS-18SM/GTX
SS-10RA
SS-12RA
SS-18RA
SS-10SMU, SS-12SMU, SS-18SMU
SS-10V, SS-12V, SS-18V

Circle (6) on Fast Fact Card



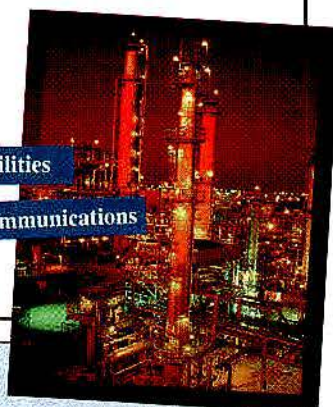
FEATURES: Towers; Wireless@Work: utilities communications; what's new in connectors; digital signal processing.

PLUS: Robert H. Schwaninger Jr.'s "In the Public Interest"; Harold Kinley's "Technically Speaking"; David Dunford's "Public safety: 10-2"; editorial commentary from Don Bishop and David Keckler.

AND IN THE MONTHS TO COME:

SCADA; portable batteries; VHF highband; surge protectors; 800MHz conventional systems; base station antennas.

Utilities
communications



EDITORIAL

Don Bishop, *Editorial Director*
Ramona Isbell, *Executive Editor*
David Keckler, *Features Editor*
Nikki Chandler, *Senior Associate Editor*
Harold Kinley, C.E.T., *Contributing Editor*
Donald E. Koehler, *Contributing Editor*

EDITORIAL ADVISORY BOARD

John Abbey, *The Abbey Group*
Stephan Beckert, *The Strategis Group*
Alan Burton, founder, *Dispatch Monthly magazine*
Gene A. Buzzi, *Omnicom Telecommunications Engineering*
Jack Daniel, *The Jack Daniel Company*
Gary David Gray, P.E., *Orange County Communications*
Frederick G. Griffin, P.E., *Frederick G. Griffin P.C.*
Jim Hendershot, *Radio Design Group*
Samuel J. Klein, *Cellular Design*
S.R. McConoughy, P.E., *Mobile Communications Consulting*
Art McDole, *Salinas, CA*
Tony Sabino, *Regional Communications*
Herb Sachs, *Herb Sachs Consulting*
Robert C. Shapiro, P.E., *Strategic Telecommunications*
Leon Spencer, *Exxon Computing Services Services*
Gregory M. Stone, Ph.D., *Quantum Radionics*
Raymond C. Trott, P.E., *Trott Communications Group*
William A. Wickline, P.E., *Mentor, OH*

PUBLIC SAFETY CONSULTANT

David O. Dunford, *Lenexa, KS, Police Department*

REGULATORY CONSULTANT

Robert H. Schwaninger Jr., *Schwaninger & Associates, Washington, DC*

DESIGN

Scott Dolash, *Art Director*

BUSINESS

Larry Lannon, *Vice President, Communications Division*
Mercy Contreras, *Group Publisher*
Patricia Kowalczyk, *Director of Marketing*
Karen Clark, *Marketing Services Supervisor*
Melissa Langstaff, *Ad Production Coordinator*
Nancy Hupp, *Director, Corporate Ad Services*
Kristi Woods, *Classified Advertising Coordinator*
Tom Cook, *Director of Editorial Development*
Doug Coonrod, *Corporate Creative Director*
Stephanie Hanaway, *Division Director of Marketing*
Sheri Gronli, *Corporate Circulation Director*
Julie Neely, *Senior Circulation Manager*
Customer Service, 800-441-0294 or 913-341-0294
Raymond E. Maloney, *Chairman*
Cameron Bishop, *President & CEO*
Ron Wall, *Chief Operating Officer*
PRIMEDIA Information Group
Curtis Thompson, *President*
PRIMEDIA Inc.
Tom Rogers, *Chairman & CEO*
Charles McCurdy, *President*
Beverly C. Chell, *Vice Chairman*

CORRESPONDENCE: Editorial correspondence should be addressed to P.O. Box 12960, Overland Park, KS 66282-2960. tel. 913-341-1300; fax: 913-967-7250; mrt@intertec.com; www.mrtmag.com.

MOBILE RADIO TECHNOLOGY provides technical information to dealers; to private wireless, public safety, public service, community repeater, SMR, ESMR, paging, cellular and PCS system operators; mobile radio equipment manufacturers; manufacturers' representatives, distributors; engineering and consulting firms; national, state and local government and public safety agencies; transportation companies; petroleum and energy products companies; public utilities; and others allied to the field.

PHOTOCOPY RIGHTS: Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by PRIMEDIA Intertec, provided that the base fee of US \$2.25 per copy, plus US \$0.00 per page is paid directly to Copyright Clearance Center, 222 Rosewood Dr., Danvers, MA 01923, USA. The fee code for users of the Transaction Reporting Service is 0745-7626/1999 \$2.25 + \$0.00. For those organizations that have been granted a photocopying license by CCC, a separate system of payment has been arranged. Prior to photocopying items for educational use, please contact CCC at 978-750-8400. Organizations or individuals with large quantity photocopy or reprint requirements should contact Jenny Eisele, 913-967-1966 or email: jenny_eisele@intertec.com.

BACK ISSUES: Copies of most issues printed within the past two years are available for \$10 per issue; older issues are not. Call customer service at 800-441-0294.

This publication is available in paper or electronic format from Information Express, 3221 Porter Drive, Palo Alto, California 94304-1225. Contact Information Express at 650-494-8787, or visit IE online at www.express.com. This publication is also available via microform and/or electronic databases from Bell & Howell Information and Learning, 300 N. Zeeb Road, P.O. Box 1346, Ann Arbor, MI 48106-1346. Contact Bell & Howell at 800-521-0600 (734-761-4700 outside North America) or check the Web site (www.umi.com) for additional information on format availability.

ADVERTISING SALES OFFICES

OVERLAND PARK, KANSAS

Joyce Bollegar, 913-967-1840,
East Region (including Eastern Canada)
Fax: 913-967-7249
Email: joyce_bollegar@intertec.com
Dawn Rhoden, *Classifieds*,
913-967-1861, Fax: 913-967-1735
Email: dawn_rhoden@intertec.com
Lori Christie, *List Rental Services Representative*,
913-967-1875, Fax: 913-967-1897
Email: lori_christie@intertec.com
9800 Metcalf Avenue
Overland Park, KS 66212-2215

SANTA ROSA, CALIFORNIA

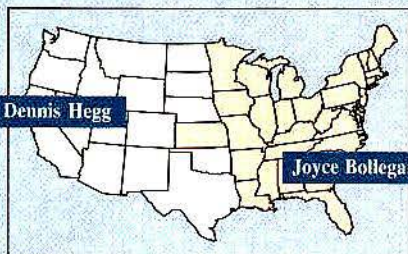
Dennis Hegg, *West region (including Alaska, Hawaii and Western Canada)*
Phone: 707-541-3763, Fax: 707-541-3721
Email: dennis_hegg@intertec.com
3428 Mendocino Ave.
Santa Rosa, CA 95403

ENGLEWOOD, COLORADO

Mercy Contreras, *Group Publisher*
Phone: 720-489-3199
Fax: 720-489-3253
Email: mercy_contreras@intertec.com
5680 Greenwood Plaza Blvd., Suite 100
Englewood, CO 80111

LONDON

Stephen Bell, *International*
Phone: +44 208 286 8889
Fax: +44 208 286 8898
Email: stephenbell@email.msn.com
P.O. Box 98
Worcester Park, Surrey, KT4 8WB
United Kingdom



Audited circulation.



INTERTEC PUBLISHING
A PRIMEDIA COMPANY

© 2000 by Intertec Publishing Corporation, A PRIMEDIA Company. All rights reserved.

Before you buy an RF personal monitor, monitor their performance.

When you look at what our competition *isn't* offering, alarms go off in your head. Relax.

Just consider everything you *will* get with Narda's personal radiation monitors. Things like guarantees. Ease of use. And performance you can count on.

So no matter what the conditions—even in the most complex, multi-signal environments—you'll get all the protection you need with Narda.

For more information, call today
631-231-1700.





narda
microwave-east

an **L3** communications company



© 1999 L-3 Communications, Inc.
www.nardamicrowave.com

		
	Narda	Competition
Frequency Range	300 kHz-45 GHz	3MHz-40 GHz
Frequency Response Error	<i>Guaranteed</i> Max. ± 2 dB	Not Guaranteed Typical +6, -10 dB
Responds equally to all field polarizations	<i>Guaranteed</i> Max. ± 0.75 dB	Not Guaranteed Typical ± 2 dB
Accurate at all temperatures	<i>Guaranteed</i>	No
Immune to static	<i>Guaranteed</i>	No
RMS detection under all conditions	<i>Guaranteed</i>	No
Functions near power lines	Yes	No
LED Indicator visible when worn on body	Yes	No
Unit cost	\$	\$\$\$
2 Year factory calibration & checkup included*	<i>Free</i> (No calibration costs for 4 years)	\$
Calibration within 10 business days	<i>Guaranteed</i> (or calibration is Free)	No

*Two-year recommended calibration cycle. No additional costs for four years with first two-year checkup and calibration included.

CALENDAR

2000

January

6-9: International CES, sponsored by the Consumer Electronics Manufacturers' Association; Sands Expo Center, Las Vegas Hilton and Alexis Park; Las Vegas. Contact: 703-907-7605 or Web site www.CESweb.org.

February

15-18: APCO Gulf Coast Regional, sponsored by the Association of Public-Safety Communications Officials-International, Corpus Christi Omni Bayfront, Corpus Christi, TX. Contact: Toni Dunne, 512-305-6918 or Web site www.apcointl.org.

15-18: NATE, sponsored by the National Association of Tower Erectors, San Diego. Contact: 888-882-5865 or Web site www.natehome.com.

28-March 1: Wireless, sponsored by the Cellular Telecommunications Industry Association, Ernest Morial Convention Center, New Orleans. Contact: 202-785-0081 or Web site www.wow-com.com.

March

6-8: APCO Western States Regional, sponsored by the Association of Public-Safety Communications Officials-International, Doubletree Hotel Portland, Portland, OR. Contact: RoxAnn Brown, 503-690-4911 ext. 206 or Web site www.apcointl.org.

19-22: ENTELEC, sponsored by ENTELEC, Dallas Convention Center, Dallas. Contact: 281-357-8700 or Web site www.entelec.org.

22-24: International Wireless Communications Expo, co-sponsored by *Mobile Radio Technology*.

Las Vegas Convention Center, Las Vegas. Contact: 800-288-8606.

April

10-12: APCO North Central Regional, sponsored by the Association of Public-Safety Communications Officials-International, Holiday Inn, Worthington, OH. Contact: Jay Somerville, 614-761-6530 or Web site www.apcointl.org.

May

8-11: Telecommunications Resellers Association Spring Conference and Exposition, Philadelphia Marriott. Contact: 202-835-9898 or Web site www.tra.org.

15-18: Spring Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Hotel Pacific Tokyo, Tokyo. Contact: 81-468-40-3552 or email matumoto@mars.yrp.nttdocomo.co.jp.

17-19: Site Owners & Managers Alliance (SOMA) Conference, sponsored by the Personal Communications Industry Association, Kansas City, MO. Web site www.pcia.com.

30-June 1: Canadian Wireless, sponsored by the Canadian Wireless Telecommunications Association, Toronto. Contact: 613-233-4888, ext. 102, or Web site www.cwta.ca.

June

4-8: Supercomm, sponsored by TIA and USTA, Georgia World Congress Center, Atlanta. Contact: 800-278-7372.

12-13: AMTA Leadership Conference and Annual Meeting, sponsored by the American Mobile Telecommunications Association, Sheraton Suites, Alexandria, VA. Contact: 202-331-7773 or

Web site www.amtausa.org.

25-29: UTC Telecom, sponsored by UTC, The United Telecom Council, Phoenix. Contact: 202-857-1881 or Web site www.utc.org.

July

16-19: Forestry Conservation and Communications Association National Conference, Elms Resort & Spa, Excelsior Springs, MO. Contact: 573-751-4115, ext. 172.

August

13-17: Association of Public-Safety Communications Officials-International (APCO) National Conference, Boston. Contact: 904-322-2500 or Web site www.apcointl.org.

September

19-22: Fall Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Seaport Hotel, Boston. Contact: 904-322-2500.

26-29: Personal Communications Showcase, sponsored by PCIA, McCormick Place, Chicago. Contact: 703-739-0300 or www.pcs00.com.

November

12-15: Telecommunications Resellers Association Fall Conference and Exhibition, sponsored by TRA, Anaheim, CA. Contact: 202-835-9898 or Web site www.tra.org.

13-14: AMTEX, sponsored by the American Mobile Telecommunications Association, Ft. Lauderdale, FL. Contact: 202-331-7773 or Web site www.amtausa.org.

15-18: Communications Marketing Conference, sponsored by the Communication Marketing Association, Sheraton Colony Square, Atlanta. Contact: 404-892-2600, ext. 300 or Web site: www.commktga.com.

EDITORIAL INDEX

American Mobile Satellite Corporation (AMSC)	29, 30
Anritsu	32
AT&T	17
Berkeley Varitronics Systems	32
Booz, Allen & Hamilton	24
Canamex Communications	32
Catalyst Communications Technologies	40
Celwave	36
CeoTronics	39
Communication Specialties	4
Communications Specialists	33
ComSpace	37, 40
Control Signal	33
David Clark	33
EAGLE	33
Emergystat Ambulance Service	29, 30, 31
FedEx	21
Forrester Research	21

Global Dispatch Technology	35
Globalstar	29, 31
Hello Direct	38
Hitachi	37
HTE	40
ICO Global Communications	29, 30, 31
Iridium	29, 30, 31
JBro Batteries	42
Marcus Communications & Electronics	4
Motorola	16, 34, 37
Narda	33
Nextel Communications	12
Noise Cancellation Technologies	39
North Supply	17
Otto Communications	33, 38
P&W Service Center	33
Positron	42
Radio Frequency Systems	36
RadioShack	17

RFS America	36
RFS	36
SatCom Systems	29, 30, 31
Schwaninger & Associates	12
Seltronics	16
Sigtronics	38
Strategis Group	4, 36
Sunflower Radio Products	4
Teledesic	30, 31
Television Equipment Associates	39
TESSCO	36
TMI Communications	30
TwitCo Distributing	39
TX RX Systems	33, 42
Vertex Radio Communications	40
W&W Manufacturing	41
Wavelength Technologies	33
Westnet	41
Zetron	16

IWCE special sessions and meetings

Motorola; "IWCE Dealer Meeting"

March 20-21
Bally's Hotel, 9 a.m. - 5 p.m. daily
Marketing and sales training; computer software and Internet training; product displays. Invitation only. Motorola dealers may contact John Cecchin, promotions specialist, Indirect Business Operations, Motorola CGISS, at caad65@email.mot.com.

Small Business in Telecommunications

"Jam Session II"
March 21
1-5 p.m.
Regulatory update; business opportunities. Robert H. Schwaninger Jr., SBT general counsel.
Registration:
202-223-8837; lawyer@sa-lawyers.net.

Simulcast Solutions

"Simulcast Update 2000"
March 23
Las Vegas Hilton
8-10 a.m.
Systems integrators recap simulcast projects; Ed O'Connor tells what's new and what's coming.
Registration: 716-223-4927;
ed@simulcastsolutions.com.

W&W Manufacturing Co.

The Leading Source For Batteries & Accessories



Largest
Selection of
NiCd & NiMH
Batteries

Two-Way Replacement Batteries



Chargers



Analyzers

All Products Made in U.S.A.

With over 20 years of manufacturing experience.

Highest Quality

95% of all battery packs are manufactured with Sanyo or Panasonic cells and Meet or Exceed the original manufacturer's battery specifications.

Widest Variety

First to Market...with the largest selection of aftermarket replacement batteries in the industry.

Customer Service

A must with W&W. Typically, all orders are shipped within 48 hours, with overnight shipments available.



W&W Manufacturing Co.

800 South Broadway, Hicksville, NY 11801

In U.S. & Canada 800-221-0732 • In NY 516-942-0011 Fax 516-942-1944
E-Mail: w-wassoc@ix.netcom.com • Web Site: <http://www.wwassociates.com>
Web Site: www.ww-manufacturing.com



The day they took the radios away

"Bob's Trucking Company" (that's what I'll call it) used to run efficiently. There was no need for useless communications stops, yet a driver knew when his orders were added to or changed. Fuel costs were lower, and engines lasted longer. Then one day, dispatchers and truck drivers came into work to find that their radios were missing.

The company had slashed the radios out of the budget. The purchasing manager said they were too expensive. What was expensive, that is, was the service contract that

had covered the radios. In fact, dispatchers and drivers said that the radios themselves had worked fine and had never *required* service, which *would* make the service contract seem like a waste of money. But the company threw out the baby with the bathwater.

Not all communications were lost. Drivers had pagers and could still stop at payphones or call at delivery stops, but a certain amount of efficiency was lost the day they took the radios away.

I learned about this situation when I asked a friend who worked as a dispatcher at Bob's what kind of radios they used. I got an earful that I didn't expect.

He said that a driver often will be out on a route, and a new order will come in for a pickup on that route. So the dispatcher will have to page the driver and then wait for him to get an update. And most likely, the driver has already *passed* that point on his route, so he will have to backtrack. "I *just* talked to him," is what is often heard around the office.

The phone calls, of course, increased "400%," according to the dispatcher, not to mention the wear and tear on trucks from more communications stops. Free-flowing voice (or data) communications between dispatcher and driver was no longer SOP for this company.

The moral of the story to end-users: Don't take your radios for granted.

To the dealers and service shops: Don't let your customers walk away. If a service contract is so expensive that a customer will completely cancel, try to deal with them. Every customer has specific needs, and you can provide the solutions, whether it's paging, or radios or mobile data terminals. Bob's might still have radios if the dealer had asked the right questions and maybe arranged a better contract that fit Bob's budget and needs.

Radio has always played an integral role in the trucking industry, from the CB radio to the mobiles and terminals of today. Mobile communications in the form of voice and data saves money and time, and in this day and age, it's hard to believe that a trucking company would take away radios *completely* if they had been serving needs. So many products are available to help trucking companies run smoothly. Take advantage of the technology to get ahead in the long-lasting transportation business.

—Nikki Chandler

nikki_chandler@intertec.com

Are you in Dispatching Hell?



Vega's Model C-6124

Get out of the heat with Vega's model C-6124, with its cool touch-screen and independent line selection. The C-6124 offers up to 24-line control, instant PTT, and loads of additional features.

Any line can be configured as a dedicated 2/4 wire radiocircuit, dial-up access or full duplex conventional PSTN telephone circuit, (simply plug in the appropriate module). Any combination of lines can be set-up in a crosspatch mode. C-6124 with its future expandability will keep you out of the inferno.



8601 East Cornhusker Highway
Lincoln, Nebraska 68507

Phone: (402) 467-5321

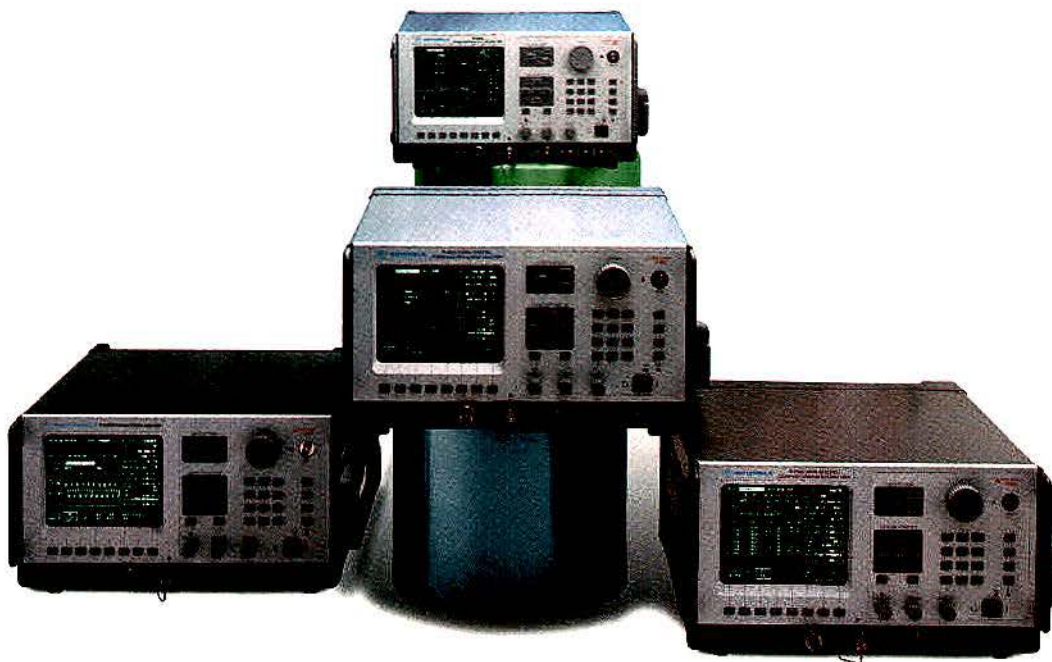
Toll-Free: 800-752-7560

Fax: (402) 467-3279

e-mail: vega_signal@earthlink.net

web: www.vega-signaling.com

Got a test?



We've got the Analyzer.

Start with our standard Communications System Analyzer platform, the rugged, dependable, easy-to-use R-2600. As your test needs grow, our upgradeable R-2600 family of System Analyzers is designed to grow with you.

For fully compatible iDEN® equipment testing, we offer the R-2660. For ASTRO®, SmartZone™, SMARTNET™, SECURENET™ and Project 25 systems compliance, you need

the R-2670. And to test MPT 1327/1343, look no farther than the Motorola R-2680.

Whatever the test, we've got the answers. For complete details or a product demonstration, contact us today:

Phone: 800-422-4210

Fax: 800-622-6210

Web: <http://AccessSecure.mot.com/Accesspoint>



Motorola, iDEN and ASTRO are registered trademarks of Motorola, Inc. SmartZone, SMARTNET, SECURENET and "The Test You Can Trust" are trademarks of Motorola, Inc. © 1999, Motorola, Inc.



MOTOROLA

Circle (10) on Fast Fact Card

You say you want a resolution?

By Robert H. Schwaninger Jr.

It's that time again for making promises. New Year's resolutions have become a staple of America, giving each of us a chance to atone for past sins by promising not to be a repeat offender. With this tradition in mind, and my fingers crossed so tight that it will take the Jaws of Life to untangle my knuckles, here's a sample of the resolutions I've considered making for 2000.

My big mouth

I promise to keep using it whenever I can. You can't swing a dead cat in Washington without hitting the timid, the clueless, the over-heeled or the cautious. I attend presentations and seminars that are so boring that I require two cardio paddles and 300 joules just to get my legs working—CLEAR! These flat-lined, flap-jawed representatives of the industry talk around every subject, without getting to the key to every operator's success: a fair competitive environment.

Last October, Chris Rogers of Nextel spoke at the SBT National Conference in St. Louis. The room was full of local operators who waited patiently for Chris to say what was really on his mind: "Why don't you guys just shut up and go away?" He didn't say that, of course. The villagers had the torches and farm implements ready to slay the monster if he had. But I'm not shutting up, and the local opera-

tors ain't going away. So, I resolve to keep running my mouth. You resolve to keep running your shop.

Our big spectrum

At another recent association gathering, the boys from the FCC once again spoke those wondrous words that always

potatoes. These were *real* potatoes sitting out in the *real* sun with millions of *real* eyes staring into his bankbook. Potatoes are real. Spectrum isn't.

I resolve to try to explain this to the FCC when the occasion arises and to do my part to direct the agency toward reality—also known as the path least taken. And if they don't listen, maybe I'll deliver a bucket of pork bellies to each of the sage commissioners. That way they can get a whiff of what we smell every time they try to tell us that they "own" spectrum.

Big band managers

I resolve to question the use of "band managers" every step of the way. Just like John Lennon asked about Brian Epstein's cut of the Beatles' earnings, the players on the industry stage should ask whether they require the bookings of these managers. I'm trying to picture Mark Crosby looking through a pair of \$500 shades and saying, "Chickee-baby, I've got a gig on a sweet little patch of 20kHz in Montana you're gonna love. Trust me. It's a natural for ya. Bring the seals and Wanda. The locals like to see the cheesecake."

The big oops

In 1995 the FCC granted a bunch of SMR licenses using a computer program that was allegedly designed to clean up the backlog of applications that had been pending for a few years. The grant of thousands of these licenses was in error. The applications, filed by the largest operator, were defective in the extreme and should not have even been included in the computer run. But, despite my repeated efforts, the FCC has yet to remedy this problem.

I resolve to find a remedy. The agency blew it, knows it blew it and



send chills up my spine and set my teeth on edge: "as the owners of the radio spectrum" Oh, puh-leeze. Don't they realize how stupid this sounds? Yet, they trot out this tired excuse for doing the least with the most.

One of my clients decided many years ago to try his hand at commodity trading. His foray into this theoretical world of pork bellies and sugar ended on a highly realistic note. When the dust settled, he owned several boxcars of

Schwaninger, MRT's regulatory consultant, is the principal in the law firm of Schwaninger & Associates, Washington, which is counsel to Small Business in Telecommunications. Schwaninger is also a member of the Radio Club of America.



Mirage:
The original NMO mounted low profile antenna.



Mirage II:
Permanent mount "NGP" version of Mirage.

ANTENNAS THAT WORK

Radiall/Larsen offers you much more than mere low profile antenna options:

- **Design innovations**
- **Expert engineering**
- **Technical precision**
- **Mechanical durability**
- **Real world tested performance**

Call today for a copy of the **Radiall/Larsen Antenna Sourcebook™** featuring our complete line of low profile antennas. **1-800-ANTENNA.**

VISIT OUR WEB SITE AT:

www.radialllarsen.com

E-MAIL: info@radialllarsen.com



Shadow:
Transit style, radome enclosed antenna.



GPS Dual Band:
Combines GPS with UHF, SMR, Cellular, Data or PCS frequencies.

RADIAL/LARSEN
antenna technologies



would prefer to sweep it under the rug so far that a 5,000hp Hoover couldn't suck it out. Even the inspector general of the FCC threw his hands up so fast you would have thought it was a stick-up. The Justice Department has punted on it. Congress is whistling and looking at the ceiling. Most of the frequency coordinators are acting like they are unaware of it. And the Government Accounting Office is still posturing. There was one decision on the matter—and it was so full of misrepresentations about the record you would have thought it was written by the Brothers Grimm—a

fairy tale of the worst order.

The big tug of war

Over the years I've found that it's easier to pull on just one side of the rope. You may not win, but at least you're a consistent jerk. So, I'm resolving to move to the front burner the issue of fundamental fairness between common carriers, demanding that local exchange carriers (LECs) give wireless operators reciprocal interconnection agreements. Although this has been *law* for a few years, the LECs are acting like Congress and the FCC didn't mean it. I

think the lawmakers *did*.

Finally, after prodding by many wireless operators, the FCC is taking the matter seriously. I've begun filing formal complaints against LECs that refuse to put a reciprocal agreement on the table. I'm tired of LECs telling paging operators, "We don't give facilities for free," as though this statement justifies charging paging companies for termination of an LEC's traffic. ("Earth to LECs.") One more time: You can't be a "supplier to all and a consumer of nothing." Those days are over.

The big show

It looks like I'll be speaking at the opening session of the IWCE show again this year. I did it last year without the benefit of coffee. (The hotel missed my wake-up call.) I like the show and

**You can't be a
'supplier to all
and a consumer
of nothing.
Those days are
over.**

enjoy the bit of free reign IWCE gives me to speak my piece. So, this year, I resolve to speak with the benefit of caffeinated beverages. It may be a wireless show, but I'll be wired in March.

The big etc.

To try to atone for all my past sins in one year would be too much. I've been guilty of many transgressions—not of least note is the sin of pride. My wife is always reminding me that I can't fix everything, can't know everything and can't be everywhere for everybody. She's right, of course. I'm just one loud-mouthed, dorsal-finned lawyer trying to make a buck the right way in Washington.

The scales of justice often have a political thumb pressing down hard on one side, and my railings are often unheard in the din of lobbyist voices, mumbling in back rooms throughout this town. My positions are about a level playing field that doesn't use big money as the only yardstick for integrity and the right to compete. But, darn it, I stand for something and in this day and age, that's something to be proud of. So, there I go again with the pride thing. But, as I've always said, if you've got an ego bigger than mine—seek professional help.

Happy New Year.

For Your Listening Pleasure.



Breeze Headset

- Designed for extended wear in active environments.
- Lightweight frame for superior comfort and fit.
- Flexible, electret boom mic.
- In-line or remote PTT switch.



Heavy-Duty Noise-Attenuating Headset

- Perfect for harsh, high-noise environments.
- Certified noise reduction rating (NRR) of 24dB.
- Flexible, noise-canceling, electret boom microphone with windscreen.
- Over-the-head and behind-the-head styles.



Lightweight Headset

- Designed for extended wear in active, moderate-noise environments.
- Flexible, electret boom mic with replaceable windscreen.
- Comfortable, adjustable foam cushion headband.
- Single or dual speaker versions.

ULTRA Lightweight Headset

- Unique "earbud" design eliminates the need for headbands.
- Ear clip holds the earbud securely in place.
- In-line PTT switch.
- Fully rotating boom mic and earbud for left or right ear use.



All You Have To Do Is Fill In The Middle.



OTTO
COMMUNICATIONS®

A World of Sound Ideas.

Carpentersville, IL ♦ Toll-free: 888-234-OTTO ♦ Phone: 847-428-7171 ♦ Fax: 847-428-1956
comsales@ottoeng.com ♦ www.ottoeng.com

Circle (12) on Fast Fact Card

iwce:2000

International Wireless Communications Expo

The Information you Need to Survive in Today's Wireless Communications Market

International Wireless Communications Expo 2000

March 22-24, 2000

Las Vegas Convention Center
Las Vegas, Nevada USA

The wireless communications industry is a competitive and expansive marketplace. As an operator, dealer, end-user or reseller, it's essential for you to keep up with the latest technology in order to compete.

IWCE 2000's educational conference and exhibition equips you with the tools you'll need to survive and thrive in this competitive environment. You'll meet mobile communications manufacturers and suppliers showcasing the innovative solutions in mobile radio, paging, RF engineering, and cellular and PCS base stations.

Join more than 10,000 industry professionals and 350 exhibiting companies in Las Vegas, March 22-24, 2000, as IWCE ushers in the future of mobile communications.

Mark your calendar now and return this coupon to receive all important show announcements!

Check out our Web site at www.iwceconexpo.com
or e-mail: trade_shows@intertec.com

Presented by:

Wireless Technology
INTERNATIONAL

MRT
MOBILE RADIO TECHNOLOGY

SITE
management
& technology

With support from these other INTERTEC/PRIMEDIA Publications: *RF Design, Satellite Communications, Global Telephony, Telephony and Wireless Review.*

- ☐ Please send me more information on ATTENDING IWCE 2000.
- ☐ Please send me more information on EXHIBITING at IWCE 2000.
- ☐ Please send me more information on SPEAKING at IWCE 2000.

Last Name _____

First Name _____

Title _____

Company _____

Address _____

City _____ State _____

Zip _____ Country _____

Phone* _____

Fax* _____

E-mail** _____

*International guests, please include city and country codes.

**Provide only if you wish to receive news and updates via e-mail.

source: AD

Please MAIL to:
IWCE 2000 Customer Service • Intertec Exhibitions
5680 Greenwood Plaza Boulevard, Suite 100
Englewood, CO 80111 USA

Or FAX to: +1-720-489-3165

Questions? Call 1-800-288-8606 or +1-303-741-2901.

Setting up the basic dispatch center

An inexpensive and simple adapter for a Maxtrac radio allows a small agency to use a logging recorder.

By David O. Dunford

Larry Pratt knows everybody. Pratt is the volunteer fire chief in Kearney, MO, the birthplace of Jesse James (forerunner of the telecom attorney). Kearney, a small but rapidly growing community of less than 5,000 people, lies in the northern "exburbs" of Kansas City, MO. Pratt has been the volunteer chief for 25 years and has steadily and progressively updated the department's training, staffing, equipment—and communications. That's where I come in—Pratt knows me, too.

The Kearney Fire Department (KFD) was dispatching on-duty and callback responders with conventional two-tone sequential paging and using a desktop Zetron encoder slaved to the base station radio. Paging range was limited by tower height and transmit power. From the days of "separate service" frequency assignments, KFD shared one of the 28 VHF high-band fire frequencies (carrier squelch) with about five or six talkative neighbors, and the system needed improvement. KFD needed to expand paging range, improve wide-area portable radio operation, and minimize co-channel chatter interference.

To improve portable operation, Pratt and I devised a plan to overlay a single-

site repeater station and modify all the field equipment by adding a new, additional channel for repeater "talk-in" use. The plan was to curb annoyance chatter by adding CTCSS to user radios. System range would be enhanced by moving the repeater station to a new PCS tower in town where Pratt knew the owners and tenants. As is typical, Kearney's regularly used simplex channel remained as the repeater talk-out channel.

At KFD's comm center in the fire station, we replaced the "senior citizen" Regency desktop with two new, inexpensive Motorola Maxtracs—one for a control station and one for backup base operation. The control station, with reduced transmit power and slaved encoder, is dedicated to dispatch operation, and the multichannel base station, with spare encoder, is parked on the statewide fire mutual-aid channel (154.280MHz, simplex). Work on user radios was simplified because most of the equipment was field-programmable by computer.

Because KFD participates in the metropolitan Kansas City E9-1-1 system, it receives 9-1-1 calls as a secondary PSAP. The Clay County, MO, Sheriff's Department is the primary PSAP that provides initial call answer and then transfers requests for fire or rescue aid.

MRT welcomes David O. Dunford as a regular columnist in 2000.

Dunford, who started in police radio as a dispatcher more than 25 years ago, is the police department technical services manager for Lenexa, KS (pop. 40,000), supervising maintenance techs, repair facilities, telecom design, fleet radio operations and mobile installations. He consults with numerous agencies on VHF/UHF/800MHz systems. Dunford is a member of APCO and has served in frequency coordination.

For his new column, we decided the appropriate title would be the 10-code "10-2"—clear communications.

Even for his small department, Pratt could see the need for operations voice logging. (Logging Rule No. 1: The actual time of day is far less important than the time relationship between actions and events of the center.)

During the transition to the new radio upgrade, an opportunity arose for Pratt to acquire a Seltronics logging recorder. After a service trial, KFD bought a model E-500, which is a small, 10-channel desktop unit that operates reliably and fits nicely in the corner of Kearney's dispatch center (fancy desk) pictured with Chief Pratt in Photo 1 below left.

To provide clean audio for recording from the phones, we picked off the handset receiver audio from the internal network on each telephone set. This simple and reliable method creates a nice audio balance between distant caller and dispatcher voice. It also records "all the lines" at this phone. (Important anti-embarrassment tip: ALL calls to/from the phone are recorded.)

We next addressed the problem of interfacing both sides of each radio conversation with the two-wire inputs on the recorder. We reviewed the literature (dug around in the Maxtrac book), and devised a strategy (scratched out a drawing) to use the radio's front-panel mic jack, because transmit and receive audio are both present there.

The schematic in Figure 1 above

Dunford, MRT's public safety consultant, is manager of technical services for the Lenexa, KS, police department. He is a member of the Association of Public-Safety Communications Officials-International. You can email Dunford at mrt@intertec.com.

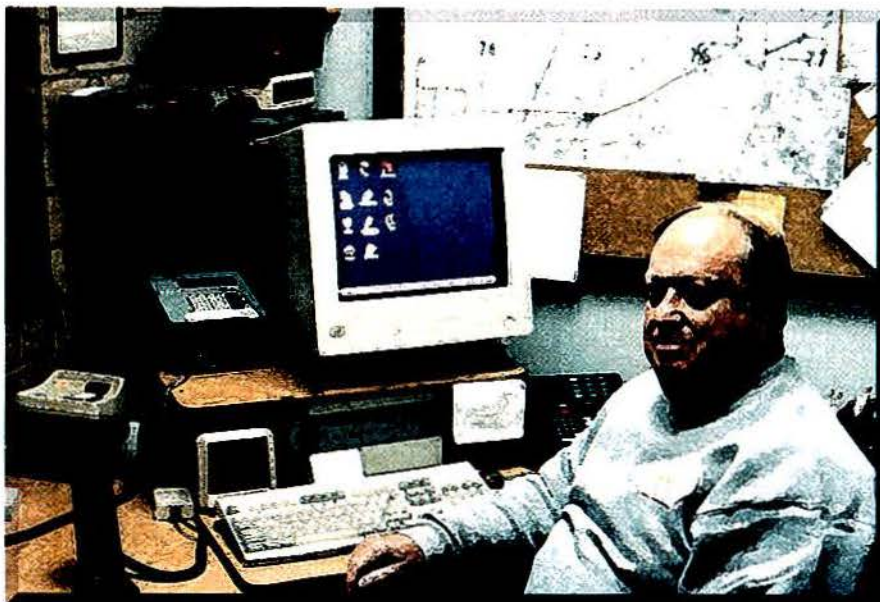


Photo 1. Small but efficient, the Kearney, MO, Fire Department Dispatch Center, supervised by Fire Chief Larry Pratt, is a one-desk operation.

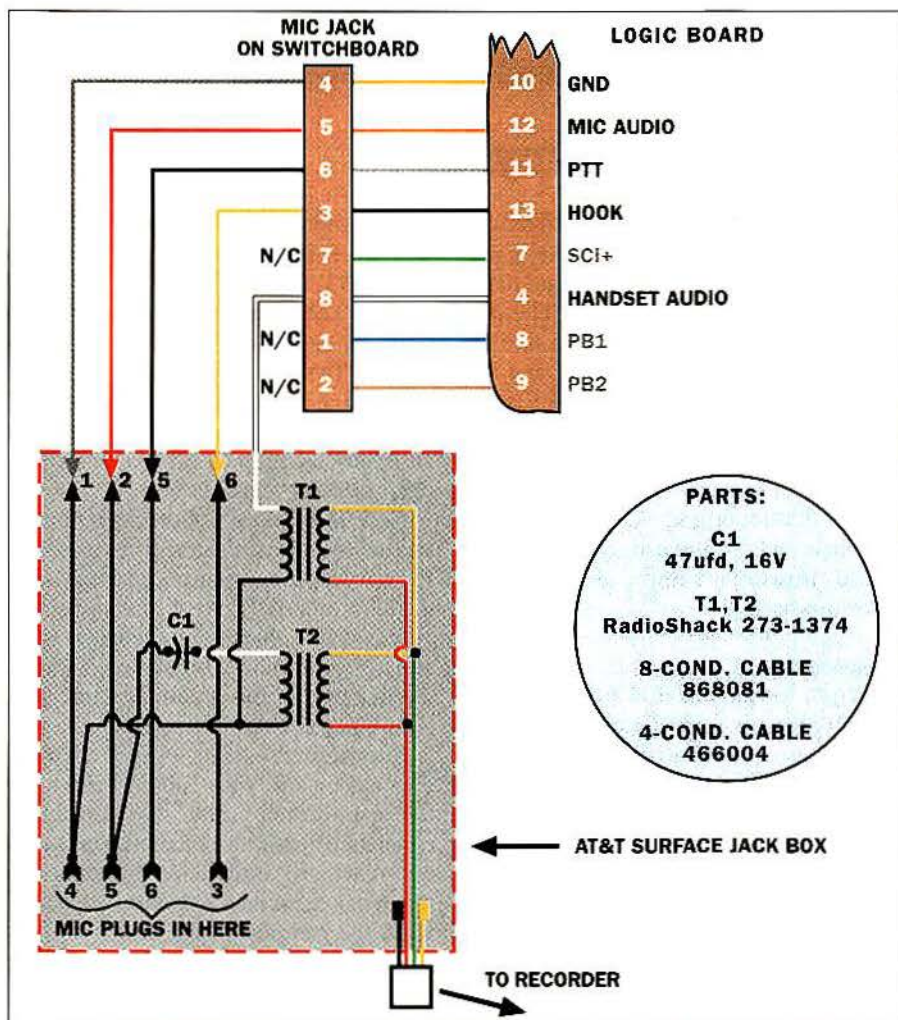


Figure 1. Wiring plan for modifying surface jack (shown in Photo 2 below) with signal components. Upper connections on the logic board (not shown) connect to the radio.

shows the wiring plan. The recorder output is bridged and isolated from separate transmit and receive audio paths and coupled together using two miniature

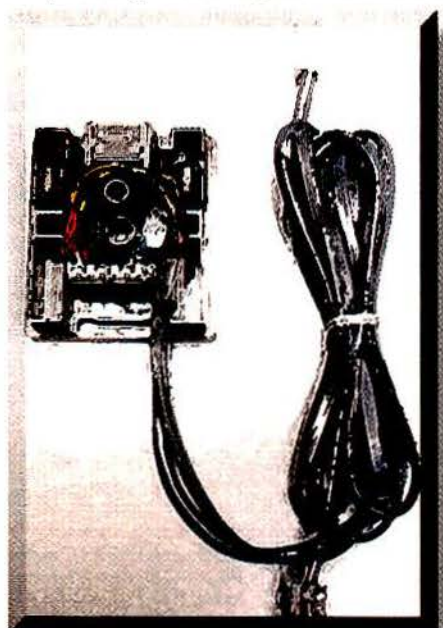


Photo 2. This AT&T surface jack was modified as shown in Figure 1 above to facilitate logger output.

transformers (Radio Shack part No. 273-1374) and a dc blocking capacitor on the microphone circuit. Using this technique, the audio balance is now excellent and the insertion loss is minimal.

For construction, we chose a four-pair AT&T surface jack that we had in stock (found in the back room) that eventually contained all the wiring and signal components. Wiring was either punched down on the type 110 connectors or made as flying connections, wrapped with heat-shrink caps. One four-wire and one eight-wire telco cord from North Supply completed the job, as shown in Photo 2 at the left. In operation, the regular desktop or palm mic plugs into the adapter box, and the eight-conductor line cord plugs into the radio mic jack. The two-wire line cord feeds the recorder interface box.

The vox recording mode works well because transmit and receive audio sources are quiet between calls.

The adapter box is cheap, dependable and assembles quickly. So, because Larry Pratt knows everybody, be sure to thank him for the idea when you see him again.

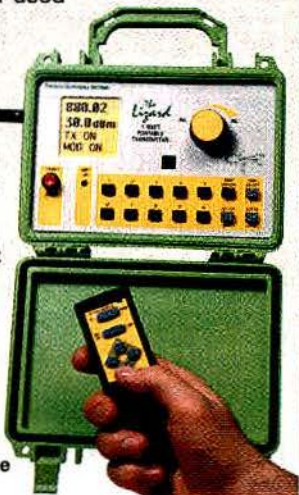
Berkeley's Newest Indoor Transmitter & Receiver

The Lizard
1 WATT

PORTABLE TRANSMITTER

A portable, battery-powered 1 watt transmitter used for indoor coverage testing.

- Self-contained module design
- 1 milliwatt to 1 watt output
- Remote control
- 128 x 128 graphic LCD with backlight
- Removable battery



13 STANDARD FREQUENCIES IMMEDIATELY AVAILABLE!



MONGOOSE

HAND HELD RECEIVER

A light weight receiver that's ideal for quick indoor sweeps by propagators.

- Internal memory stores signal strength that can be output to a PC with a serial cable
- Large graphic EL backlit display allows user to view any 3 channels simultaneously
- Rechargeable Ni-Cad Battery
- Audio can be heard through headphone jack or an internal speaker
- Available in most popular frequency formats
- Weighs under 5 lbs. (including battery)



BERKELEY VARITRONICS SYSTEMS

Call us today for more information:

732-548-3737 / Fax: (732) 548-3404

Internet: www.bvsystems.com

E-mail: info@bvsystems.com

Circle (14) on Fast Fact Card

Transmission lines: unravelling the mystery

By Harold Kinley

RF transmission lines have always presented an element of mystery. However, understanding the behavior of transmission lines is important to those of us who routinely work with these conduits of RF energy. Call them feedlines, transmission lines or simply "coax"—the purpose is to get energy from a transmitter output to an antenna, or from an antenna to a receiver input.

Non-resonant lines

When a transmission line is terminated in its characteristic impedance, all

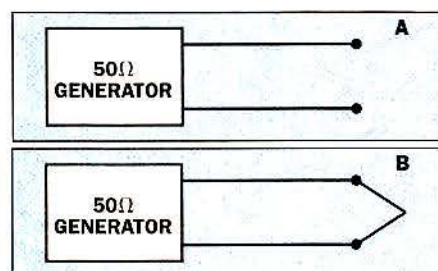


Figure 1. (A) A 50Ω transmission line that is unterminated, or open-circuited, at the end. The behavior of such a line is described in Table 1, below. (B) A 50Ω transmission line that is short-circuited at the end. The behavior of such a line is also described in Table 1.

of the power delivered to the load by the incident (forward-traveling) wave is absorbed by the load. The line is said to be *non-resonant* in this situation. The impedance at each point along the line, at any point between the generator and the load, is the same. There is no reflected wave on the line. The impedance will be equal to the characteristic impedance of the line. The length of the line in this case is not important, except where loss is concerned. You might say that, compared to resonant lines, non-resonant lines are boring.

Resonant lines

When a transmission line is terminated with an impedance that is *not* equal to the characteristic impedance of the line, things change. The impedance along the line between the generator and load varies but repeats at every half wavelength ($\lambda/2$) from the load. The load impedance may be purely resistive, or it may contain an element of reactance, either inductive or capacitive.

In Figure 1A at the left, a 50Ω transmission line (in a 50Ω radio system) is open-circuited at the load end. This is a theoretically perfect transmission line. It exhibits no loss and has a velocity factor of 1. Let's look down the line

from the load end toward the generator, or source, in *one-thirty-second-wave-length* ($1/32\lambda$) increments. We only need to cover $\lambda/2$ of line because the situation starts repeating at $\lambda/2$. The second column in Table 1 below shows what the impedance will be at each incremental point on the line. Remember, this is for an open-circuited line—a near-perfect open circuit.

Now, if we place a short circuit on the end of the transmission line shown in Figure 1B, the situation changes. The third column of Table 1 (for the short-circuited line) lists the impedance value at each location moving from the end of the line toward the generator. This is for a near-perfect short circuit.

Some interesting points can be gleaned by studying Table 1. First, for the open-circuited line, the impedance consists of infinite resistance and infinite reactance at the end of the line. As the distance increases down the line (toward the generator), the resistive component becomes 0Ω and the inductive reactive component decreases until it reaches 0Ω at $\lambda/4$ from the end of the line. Thus, $\lambda/4$ from the end of the line, the impedance has shifted from an open circuit to a short circuit—a complete impedance transformation.

Now, moving further down the line from the end, between $\lambda/4$ and $\lambda/2$, the resistive component remains at 0Ω while the reactive component switches from inductive to capacitive and increases up to infinity (∞) at the $\lambda/2$ point. It is interesting to note that the reactive component is equal to the characteristic impedance of the line at both the $\lambda/8$ and $3\lambda/8$ points. However, at the $\lambda/8$ point, the reactance is capacitive, but it is inductive at the $3\lambda/8$ point. At the $\lambda/2$ point, the impedance again becomes infinity ($\infty \pm j\infty$). Thus, the impedance repeats at $\lambda/2$. This entire sequence would repeat for every $\lambda/2$ section of the transmission line. So, it is only necessary to study $\lambda/2$ section of

Table 1. The first column represents the distance from the end of the line in $\lambda/32$ wavelength increments. As shown here, the impedance repeats at every half wavelength and inverts at every quarter wavelength. These figures represent the situation with a lossless transmission line.

DISTANCE FROM LOAD (λ)	OPEN-CIRCUIT LINE IMPEDANCE (Ω)	SHORT-CIRCUIT LINE IMPEDANCE (Ω)
0/32	$\infty \pm j\infty$	$0 \pm j0$
1/32	$0 - j250$	$0 + j10$
2/32 = 1/16	$0 - j120$	$0 + j21$
3/32	$0 - j75$	$0 + j33$
4/32 = 1/8	$0 - j50$	$0 + j50$
5/32	$0 - j33$	$0 + j75$
6/32 = 3/16	$0 - j21$	$0 + j120$
7/32	$0 - j10$	$0 + j250$
8/32 = 1/4	$0 \pm j0$	$\infty \pm j\infty$
9/32	$0 + j10$	$0 - j250$
10/32 = 5/16	$0 + j21$	$0 - j120$
11/32	$0 + j33$	$0 - j75$
12/32 = 3/8	$0 + j50$	$0 - j50$
13/32	$0 + j75$	$0 - j33$
14/32 = 7/16	$0 + j120$	$0 - j21$
15/32	$0 + j250$	$0 - j10$
16/32 = 1/2	$\infty \pm j\infty$	$0 - j0$

Contributing Editor Kinley, MRT's technical consultant and a certified electronics engineer, is regional communications manager, South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual, with Instrumentation and Testing Techniques*, which is available for direct purchase. Write to 204 Tanglewyld Drive, Spartanburg, SC 29301.

Kinley's email address is hkinley@home.com.

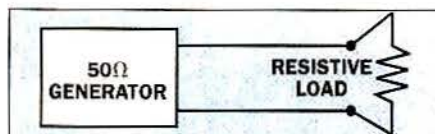


Figure 2: A 50Ω transmission line is terminated in a purely resistive load that is unequal to the characteristic impedance of the transmission line. See text for examples.

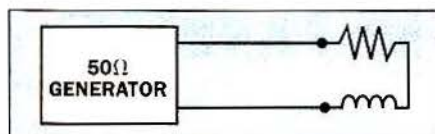


Figure 3: This 50Ω transmission line is terminated in a complex impedance load consisting of a 25Ω resistor and an inductive reactance of 25Ω. See text for details.

line to understand what is happening on the entire line.

The third column of Table 1 summarizes what happens with a short-circuited transmission line. Of course, at the short-circuited end, the impedance is $0 \pm j0\Omega$. Between the end of the line and the $\lambda/4$ point, the reactance is inductive. This is the reverse of the open-circuited line. Again, at the $\lambda/8$ and $3\lambda/8$ points, the reactance is equal to the characteristic impedance of the line. At the $\lambda/4$ point, the impedance becomes an open circuit ($\infty \pm j\infty$). Between the $\lambda/4$ and $\lambda/2$ points, the reactance switches to capacitive reactance. And, at the $\lambda/2$ point, the short circuit at the end of the line is repeated and will do so at every multiple of $\lambda/2$ down the line toward the generator.

From this it can be concluded that for an open- or short-circuited transmission line, the impedance at any point between the end of the line and the $\lambda/2$ point will consist of 0Ω resistance and a reactive component that extends from 0 to infinity. Note that for an open-circuited line, the resistance component switches abruptly from 0Ω to infinity at the $\lambda/2$ point and every multiple thereof referenced to the end of the line. Conversely, for a short-circuited line, the resistance component switches abruptly from 0Ω to infinity at the $\lambda/4$ point and every odd multiple thereof referenced to the end of the line.

It can further be stated that if the load impedance is *purely resistive* and *greater than* the characteristic impedance of the line, the reactance will be *capacitive* at any point between the end of the line and $\lambda/4$ from the end, and *inductive* between the $\lambda/4$ and $\lambda/2$ points. If the load impedance is *purely resistive* and *less than* the characteristic impedance of the line, the reactance will be *inductive* at any point between the

end of the line and the $\lambda/4$ point, and *capacitive* between the $\lambda/4$ and $\lambda/2$ points.

Figure 2 at the left illustrates a transmission line, with a characteristic impedance of 50Ω, terminated with a load that is a pure resistance of 25Ω ($25 \pm j0$). The VSWR will be 2:1. We can determine the impedance at $\lambda/4$ from the end of the line by using the following formula:

$$Z_1 = \frac{Z^2}{Z_L}$$

where Z is the characteristic impedance of the line, Z_1 is the impedance at the $\lambda/4$ point and Z_L is the load impedance. In Figure 2, the load impedance is a pure resistance of 25Ω and the characteristic impedance of the line is 50Ω. Now, plugging these values into the equation above we get:

$$Z_1 = \frac{50^2}{25} = \frac{2,500}{25} = 100$$

Thus, the impedance at the $\lambda/4$ point is 100Ω. The VSWR will still be 2:1. Assuming a lossless line, the VSWR at any point on a line will be the same.

If in Figure 2 the 50Ω transmission line was terminated by a load with a pure resistance of 100Ω, the VSWR would still be 2:1. The impedance at a point $\lambda/4$ away from the end (according to the formula above) will be:

$$\frac{50^2}{100} = \frac{2,500}{100} = 25$$

Suppose the line is terminated in a complex impedance, one that contains both resistive and reactive components. The formula still holds true, but now we must enter the load impedance in complex form. In Figure 3, a 50Ω transmission line is terminated in an impedance of $25 + j25$ ohms. Plugging this into the formula we get:

$$Z = \frac{50^2}{(25 + j25)} = \frac{2,500}{(25 + j25)} = \frac{2,500}{25(1 + j)} = \frac{100}{(1 + j)}$$

$$= \frac{100}{(1 + j)} \times \frac{(1 - j)}{(1 - j)} = \frac{100(1 - j)}{2} = 50 - j50$$

Thus, the impedance $\lambda/4$ down the line is equal to $50 - j50\Omega$. The inductive reactance present in the load impedance has been transformed into capacitive reactance at the $\lambda/4$ point down the line. To reiterate, *although the impedance on the line changes, the VSWR does not change.*

Next month's column deals with practical applications of this information.

So, until next time ... stay tuned! ■

CELLULAR, PCS & WIRELESS LOCAL LOOP MICRO FILTER PROTECTION

THE
INDUSTRY'S
FINEST
LIGHTNING
PROTECTION
PRODUCTS



SX SERIES

- Low VSWR and Insertion Loss
- dc Blocked
- Multi-Strike Capability
- Cellular, PCS & Wireless Local Loop Frequency Ranges Available
- Industry's Best RF Performance
- Maintenance Free
- Fully Weatherized Housing



[Actual Size]

PolyPhaser®

A SMITHS INDUSTRIES COMPANY

P.O. Box 9000, Minden • NV 89423-9000 USA

Tel (800) 325-7170 (775) 782-2511

Fax (775) 782-4476 • www.polyphaser.com

ISO 9001 CERTIFIED

Circle (15) on Fast Fact Card

Wireless @Work

FedEx and land mobile

Private wireless spectrum plays a crucial role in the operations infrastructure of one of the world's largest courier and business delivery services.

By Thomas G. Dolan

Santa Claus supposedly just completed a phantasmagorical worldwide delivery of packages in one night. Another entity performs an equally Herculean task: worldwide distribution of 3.1 million packages, weighing more than 7 million pounds—*every* night. This delivery artery doesn't just carry gifts, it carries the lifeblood of worldwide commerce.

How does FedEx do it?

It takes many different ingredients, all linked by a vast communications infrastructure that includes land mobile radio.

In 1971, Memphis, TN-based Federal Express was incorporated. (The company was officially rebranded as "FedEx" in 1994.) The FedEx mission of transporting time-sensitive goods door to door reliably—and overnight—was a radical idea based on a simple "hub-and-spoke" model. The company would fly packages to a central location, sort them, load them back onto planes and fly them to their destination—all in the middle of the night.

The FedEx idea attracted entrepreneurial employees and investors who were willing to dream big. The company bought a squadron of Dassault Falcon jets, many of which had been collecting dust in the New Mexico desert. At the time, it was the most heavily financed startup in U.S. transportation history.

On April 17, 1973, working out of World



War II-vintage Air National Guard hangers in Memphis, FedEx started operations serving 25 cities. The company delivered 186 packages that first night, using 389 employees. It's amazing when you think about it—about two employees per package.

To measure the distance covered since then, consider a few staggering numbers. Generating \$14 billion in annual revenues, FedEx now delivers about 3.1 million packages daily to 210 countries. It takes some 148,000 employees shipping via 634 aircraft and more than 42,500 vehicles worldwide.

The development of the communications infrastructure to support this phenomenal growth has been a process of invention for FedEx. Nathan Lemmon, chief engineer for Wireless Systems Development in Memphis, pointed out that there was no precedent.

"When FedEx invented this industry in 1973, no one (not even the inventor) understood the volume, or the real-time nature of the communications that would be required to make it work," Lemmon said. "When your entire business cycle is only 24 hours, you can't spend a lot of that time communicating. Within five to six years of initial launch of service, our business growth was being throttled by the inability to dispatch our couriers in a

timely manner. The business was out there, but we couldn't get the information to our workforce. In the late '70s, early '80s, there were no wide-area voice systems, much less data-capable networks. So we had to invent wide-area voice and data capability as well."

Lemmon said that the availability of private wireless spectrum to facilitate such an operation is critical.

"It's ironic that 20 years later ... there are still no commercial wireless providers offering wide-area, integrated, packet data and dispatch voice services," Lemmon said. "While some providers are rumored to be close, and some providers are promising, you can't run a time-critical business on rumor or promises."

"Even when a public provider can offer the basic feature set that FedEx requires to maintain current mobile workforce productivity levels, it will take several years, if ever, for this provider to match our current wide-area coverage and low operating cost."

In 1980, radio contact with fleet vehicles was augmented with the digital transmission of data to in-vehicle terminals. The Digitally Assisted Dispatch System (DADS) began guiding couriers to their next pickup.

Keith McGarr, vice president, network computing, said that since the company added data to its mobile radio installations in the early 1980s, it now has one of the world's largest private mobile data networks. Operating on an IEEE 802.11 wireless messaging standard at 800MHz, the wireless network connects to some 83,000 couriers online.

The digital specifications for the mobile data/radio units were developed by FedEx; M/A-COM, Lowell, MA, designed the mobiles and base stations to spec. "The architecture evolved as we worked with M/A-COM on tweaking and optimizing the software and hardware," Lemmon said. M/A-COM is still FedEx's only supplier of the technology.

The units not only support accurate dispatching but also the multiple changes and adjustments that such a magnitude of deliveries entails. In the

United States alone, daily routes driven cover more than 2.7 million miles.

In addition to courier communications, there are other focused uses for land mobile radio. Take, for instance, the authorized shipcenters, of which



there are more than 7,600. The largest, the superhub at Memphis headquarters, employs 12,200 people working in 2.4 million square feet of floor space. Coordination of package handling is critical, with a box sort capacity of 160,000 pieces per hour and a document sort capacity of 325,000 pieces per hour. Radio support for this process is essential, with about 3,000 employees on the wireless network. Aircraft mechanics and other support employees in the 1,400 world service centers also require wireless communications support for their tasks.

Network-wide, FedEx uses about 40,000 mobile data/voice units and about 2,500 hand-held data terminals. About 760 base stations support the network on leased tower space. FedEx owns all the fixed equipment and manages and operates the network of about 600 different sites.

"Our coverage is somewhat less than analog cellular, but more than Ardis or BellSouth Wireless Data. It's not all digital yet. We've been rolling out our second-generation digital technology for about 18 months, and we're at about 10,000

units, or approximately 25% of the fleet," Lemmon said in December.

The RF systems support for this vast network requires the services of about 300 field service techs who do the end-to-end service under the control of the Memphis-based RF Network Control Center, composed of around 10 technicians. Another 10 Memphis-based technicians do the depot-level repairs and support the RF and mobile data terminal devices, Lemmon said.

"Base station maintenance is contracted to local radio shops and dispatched from Memphis, based on input from our field techs and

Network Management System," he said.

Although traditional radio plays an integral part in FedEx's overall communications, it is but one strand of a communications network.

FedEx has deployed 2.4GHz (ISM) wireless LANs at its hubs for wireless scanning and packet data applications, in addition to the private trunked radio systems. A new digital mobile has the option for an internal GPS receiver. Lemmon said that the cost justification for roll-out is now being reviewed. "As our real-time, on-route package-

FedEx headquarters

Worldwide: Memphis, TN
Asia: Hong Kong
Canada: Toronto
Europe: Brussels, Belgium
Latin America: Miami

FedEx company statistics

Revenues: \$14 billion, fiscal year 1999
Employees: More than 145,000 worldwide
Countries served: 210
Mobile radios used: 40,000
Base stations: 760
Aircraft fleet: 634 worldwide
Vehicle fleet: More than 42,500 worldwide
Average package volume: More than 3.2 million daily worldwide
Average call volume: More than 500,000 calls daily
Distance driven per day: More than 2.7 million miles (just in the United States)
Internet: More than four million monthly hits; more than two million packages tracked per month

Dolan is a freelance telecommunications writer.

tracking application gives us the last known location of our courier, we've had the luxury of waiting for the cost of GPS receivers to become a non-issue," he said.

FedEx has always been on the cutting edge of technology, but in the past the growth of various communications systems (mobile radio, circuit-switch telephone, main-frame computers, satellite systems) occurred separately as distinct networks.

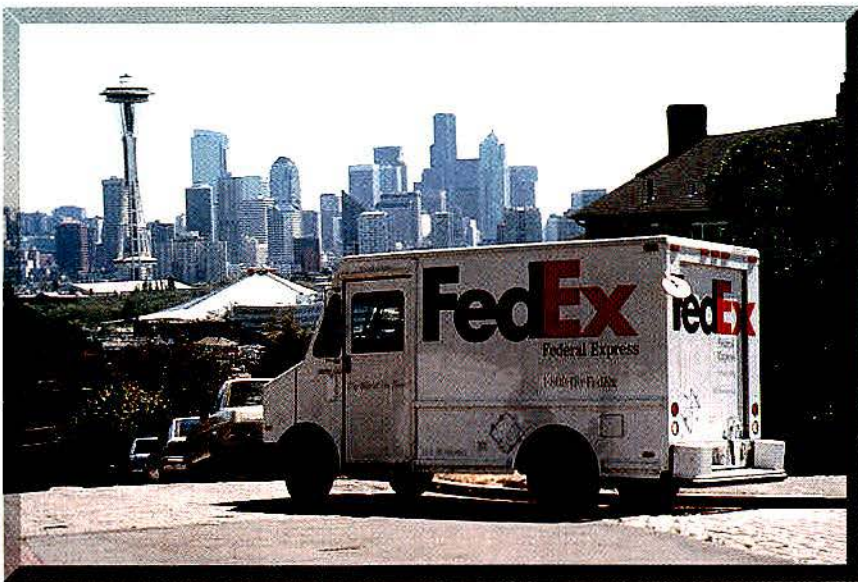
"But, what has evolved over the past three years is the convergence of wireless, voice, video data, satellite and wide-area networks all into a common digital infrastructure," McGarr said. "It looks like a common virtual network, with a coming together of all of the different content built on the Internet protocol (IP) standards."

The whole point of FedEx's commu-

nications network is that it appears seamless and transparent to the user, whether that person is a sales or customer service rep, a courier or a network

ment. The content is all translated into the same system and then sorted and dispersed again as needed. Call volume averages more than 500,000 transactions per day, plus 60 million electronic transmissions.

There is also an entirely different, but equally important, aspect to communications for FedEx. "It's fundamental to understand that, from our early days, we realized that the movement of information was just as important as the package," McGarr said. "The ability to have real-time control over where the package is and when it will be de-



engineer. The same holds true for the customer, whether he makes his connection by a physical drop at a shipcenter, or by using telephone, email, radio or any other medium to request a pickup or to query the status of a package or docu-

delivered is critical to the customer."

FedEx realizes that, for commercial customers, delivery is one link in a complex "supply chain" that extends from a company's suppliers to its customers. Managed strategically, the supply chain

FEEL THE POWER ...

**Block Out Noise.
Beef Up Productivity.**

Earmark radios add safety and efficiency to any job. Out of your line of sight? No problem with continuous communication. Need to be hands-free? Earmark radios have no hard-wired limitations. Working in loud environments? Each Headset radio is built into noise reducing earmuffs rated at 23NRR. Or, put the weight at your waist with an Earmark Belt-Pak™ and plug in one of our tailored high noise or low noise headphones. Feel Earmark Power! For more information and a **FREE** trial, call our product specialists at (888) EARMARK (327-6275).



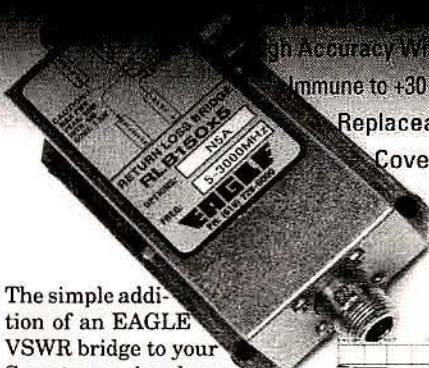
EARMARK®

1125 Dixwell Avenue, Hamden, CT 06514
Phone (203) 777-2130, Fax (203) 777-2886
<http://www.earmark.com>

ULT2

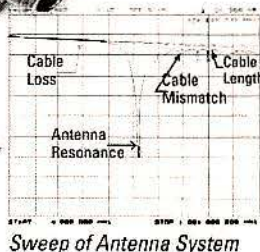
Circle (41) on Fast Fact Card

EASY ANTENNA MEASUREMENTS Using VSWR BRIDGES



The simple addition of an EAGLE VSWR bridge to your Spectrum Analyzer/Tracking Generator allows quick and easy antenna system measurements. Why spend thousands for a handheld device when you have most of the solution already?

High Accuracy Without Cal Routine
Immune to +30 dbm Interference
Replaceable Center Pins
Coverage to 3.0 GHz
Low Cost: \$629
5 Watt Power



Sweep of Antenna System

PLEASE call for FREE application note:

"Antenna and Feed-line Measurements"

EAGLE

VOICE: (520) 204-2597 ♥ email: eag@sedona.net

FAX: (520) 204-2568 ♥ Box 4300 Sedona, AZ 86340

Circle (39) on Fast Fact Card

can yield significant advantages that include lower distribution and inventory costs, improved profitability, enhanced customer service and satisfaction, and shorter transit times to market. These advantages can translate into more time for product innovation, customization and quality. ■

FedEx information technology

In getting the package from "here" to "there," FedEx uses a number of procedures derived from \$1.4 billion it budgets for technology. Here are some of the key ones:

- The information network that tracks the movement of every shipment in the system is called Customer Oriented Service and Management Operating System (COSMOS). In a typical month, customers tap into COSMOS via the Internet nearly two million times for an update on shipment status.
- The "Supertracker" is what FedEx calls the process through which a hand-held scanner captures information on each FedEx package with a quick scan of the package's unique bar code. Each package receives as many as 10 scans, from pickup to delivery, pinpointing the real-time status of the package en route. New technology will address the problem of incorrectly addressed packages by letting couriers verify addresses at the time of pickup.
- "Automated Sorting Tracing Routing Aid" (ASTRA) is the official name for the unique bar code on every FedEx shipment, generated when customers use the FedEx electronic shipping system of whenever packages enter the system. Encoded on the label are data such as destination, service requested and commitment time. In a FedEx hub, the ASTRA label aids in correct sorting and routing.



Ceotronics
Audio · Video · Data Communication

Ceotronics, Inc.
2340 Trinity Mills Road
Carrollton, Texas 75006
Tel. (972)416-9500, Fax (972)416-9580

TC 917 Technologically Convincing!

A perfect headset with integrated UHF transceiver offers:

- Noise cancelling
- Hands free communication
- Voice operated transmission

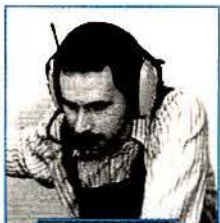
All in One!

Ideal for wireless communication in noisy areas

- Heavy machinery
- Construction
- Crane operation
- Sport arenas etc.

Ceotronics... when it really counts!

For further details phone or write
E-Mail headsets@altinet.net
<http://www.ceotronics.com>



Circle (38) on Fast Fact Card

Geographic Signal Coverage At Your Fingertips.

The STI-9400 Mobile Signal Measurement and Analysis System

From automated field measurement to analysis and report, the STI-9400 is the most cost-effective and easy-to-use signal measurement and coverage analysis system on the market.

Select a receiver for AMPS, SMR, GSM, CDMA, etc. to be integrated into the STI-9400, or an interface/driver for automation of popular spectrum analyzers and service monitors for drive-test signal measurement.

Analyze your signal measurements on the STI-9400 screen and create reports in the field. The STI-9400 instantly creates signal coverage "contour plots" and statistical measurement summaries.

The STI-9400 comes complete with street map data for the entire USA and is also compatible with .TAB map files.

The first step toward improving system coverage is to understand current system performance.



STI Survey Technologies Incorporated

"Geographic Signal Coverage At Your Fingertips."

877-848-8500 toll free

local: 503-848-8500 fax: 503-848-8534

<http://www.surveyttech.com>

Email: marketing@surveyttech.com

17980 S.W. Shadypeak • Beaverton, OR 97007

Circle (16) on Fast Fact Card

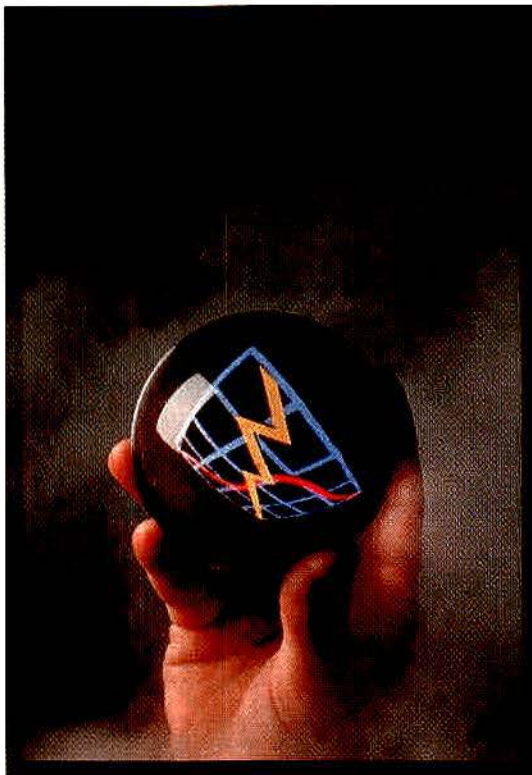
Predicting radio channel capacity

Use patterns in a conventional two-way system affect channel capacity, which can be predicted using a voice message analogy similar to a data packet. User effects can then be modeled with an adaptive user-protocol concept.

By Stephen E. Bartlett, B.S., M.S.

Individuals involved in the design and support of conventional two-way radio systems may have asked themselves at one time or another, "What is the *real* capacity of this single radio channel anyway?" Over the years, figuring out the actual capacity of a single channel has seemed a bit elusive. Although single channel capacity is not constant, it is predictable. It's no surprise that as more users try to access a system, it becomes congested. What *is* a surprise is another dimension to the problem that isn't so obvious.

This article presents an approach to understanding why and how land mobile channels can get congested so quickly during periods of heavy use. This approach models the radio user as an "adaptive protocol machine." Specifically, the user's radio etiquette is treated as an analogy to protocol schemes that control communications channels. In the context of this article, "protocol" applies to the relaying of voice communications between two users on a single shared



conventional channel (non-trunked).

Multiple-access channel

The conventional land mobile radio is

a shared, multiple-access medium with several users competing to use it. These users randomly capture the channel, one at a time, and fill it with voice messages of varying lengths, each separated by a random idle time. (See Figure 1 below.) Given this constant competition, a user's radio etiquette, or protocol, can determine how effectively a single channel can be shared by many. The concept of a multiple-access communications medium is more popularly identified with packet radio or LANs. However, it can also apply to the conventional channel if the following analogies are made between parameters that define a packet data channel and a conventional voice channel:

❑ Channel capacity: typically measured in *data bits per second*. The conventional channel analogy is *voice messages per minute*.

❑ Packet: defined for data in *bits per frame per transmitted packet*. For the voice analogy it can be defined as *seconds per message per PTT*.

❑ Collision vulnerability window: generally defined in data channels as *propagation time vs. packet time*. A voice channel analogy can be PTT activation time vs. idle time between messages.

❑ Protocol: a tightly followed procedure programmed in data modems. The voice radio analogy can be thought of as a loosely followed radio behavior (etiquette) in humans.

❑ Throughput delay: total time to successfully receive a complete message (consider these equal for both the data and the voice analogy).

The mathematics for calculating the throughput capacity of a data channel can be scaled with these

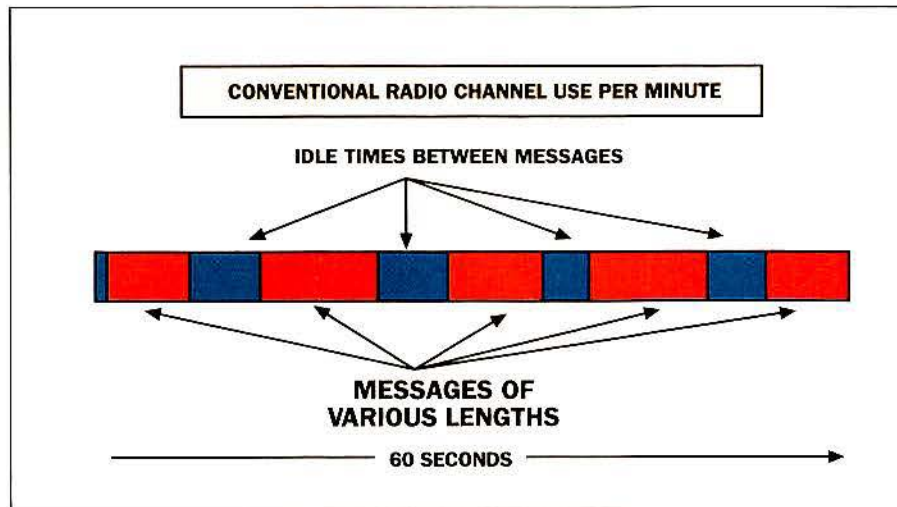


Figure 1. Conventional channel message packet analogy.

Bartlett is a senior wireless engineer and senior associate at Booz, Allen & Hamilton, McLean, VA. His email address is bartlett_steve@bah.com.

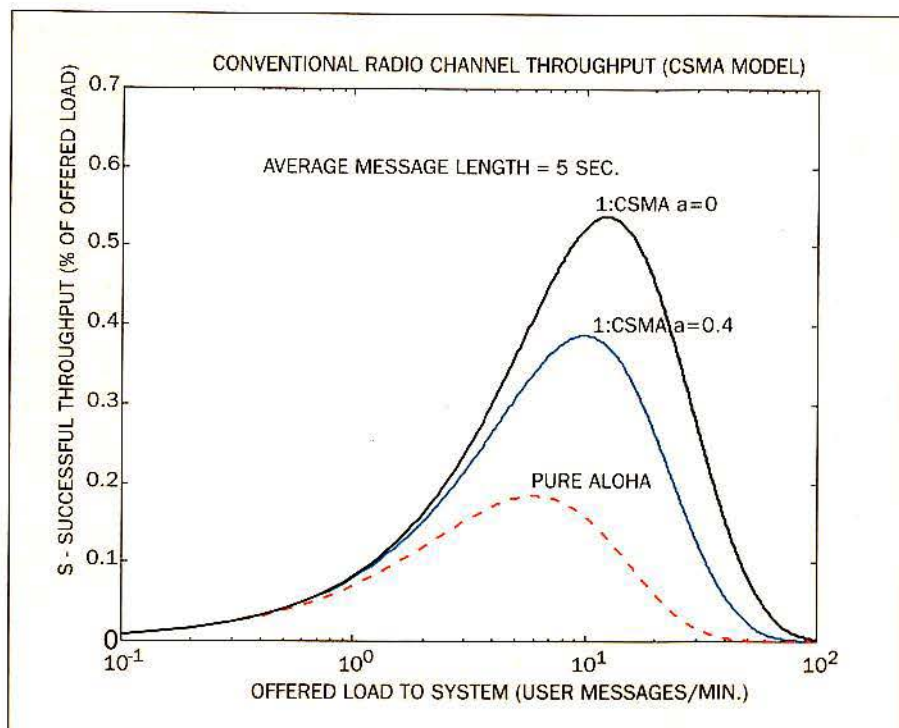


Figure 2. Various protocol curves of throughput vs. offered load for different vulnerability window values, a , with five-second messages.

analogous channel parameters to calculate the expected throughput capacity of voice messages in the conventional channel. (Based on statistics of random events.)

Protocol

A protocol is a set of rules governing the use of a communications medium. Protocols are programmed into several layers of a communications system to

promote efficient use of the communications medium and to ensure optimum throughput. Generally, protocols are designed to ensure that most of the offered load (a transmitted message) becomes a successful throughput (a message successfully received and understood). Several types of multiple-access schemes exist, but only two are considered for this adaptive user definition—pure ALOHA (non-slotted), a *transmit when ready* scheme, and carrier-sense, multiple-access (CSMA), a *transmit after listening* scheme.

Adaptive user protocol concept

To illustrate the adaptive user protocol concept, consider the typical user's call behavior when using a conventional channel, and how it mimics the ALOHA or CSMA protocols previously described. The user will either:

1. Transmit immediately without regard to whether the channel is being used.
2. Listen until the channel is idle before transmitting. When the channel is idle, the user may (a) transmit immediately, (b) wait a random time before transmitting or (c) choose not to transmit at all and try later.

Each of these user choices represents a different type of multiple-access

Dispatch Made Easy.

Now one headset can connect to both your phone and radio.



Phone



Radio

SwitchMate II

Easy to use, the SwitchMate II is the only device that lets you converse on a telephone and then instantly switch to transmit on a two-way radio.

- Compatible with both analog and digital radios and telephones.
- Select from many styles of lightweight headsets.
- Convenient foot switch for hands-free use.

Call 800-346-6442 today for a faxed quotation.

www.radiomate.com

RadioMate®

protocol scheme. The behavior in Case 1 illustrates pure ALOHA, with the user transmitting without regard as to whether the channel is busy. The Case 2 behavior is similar to a CSMA scheme with a listening action (carrier sensing) prior to transmission (access). Each subsequent transmit decision in Case 2 is defined by a range of probabilities that the user will transmit in the idle timeframe. This is referred to as the *persistence probability* and is represented by p , with values from 0 to 1.

For instance, the immediate transmit decision in Case 2a pertains to a

1-persistent CSMA, meaning there is a 100% chance that an immediate transmission will take place when the channel becomes idle. The Case 2b decision, waiting a random time before transmitting, represents p -persistent CSMA, reflecting the distributed probability of transmission among all users, some of whom may choose immediate transmission ($p = 1$), and some of whom may choose to wait a while ($p < 1$).

The choice to not transmit at all but to try again later, Case 2c, represents n -persistent CSMA ($p \sim 0$). Many conventional LMR systems have users falling

in either the p -persistent CSMA or 1-persistent CSMA protocol category. The study on which this article is based assumed 1-persistent CSMA behavior by all users, choosing to transmit as soon as the channel is idle.

For normal (light to moderate) radio traffic, most users will exercise proper radio etiquette, resulting in channel stability, high potential channel throughput and minimum throughput delay times (no waiting, no message repeats). When a crisis occurs, more users attempt to communicate on the channel, resulting in more messages with fewer, shorter times between messages to gain access. This behavior increases the chance for message collisions, especially as users grow impatient from waiting a long time for the chance to transmit. In turn, this result increases the throughput delay because of wait times and repeated messages caused by collisions.

On a collision path

Concerning collisions, it is important to note that in the conventional LMR channel, no immediate collision awareness exists because the receiver is muted during a transmission. Therefore, a user won't know if another user is transmitting at the same moment. Consequently, these messages collide and both users continue talking, each assuming exclusively channel access. Both messages are unintelligible (because of distortion from radio heterodyne, in most cases).

During this collision, the channel is unusable to others and is actually blocked until both users finally release their PTTs. This situation further increases throughput delay and reduces channel availability for everyone. In extreme crisis situations, some users may forget their proper radio etiquette and become a bit selfish. More users may transmit without waiting for the channel to become idle and try to "punch through" the radio clutter. Such action causes many more message collisions and the channel starts sounding like a continuous stream of noise with no discernible communications.

Eventually, the effective throughput of the channel is reduced to nearly zero. Such anxious user behavior mirrors the pure ALOHA multiple-access protocol scheme. No listening is being done, and users are transmitting whenever they feel like it, just hoping to get through.

Protocol simulation

To test the utility of this concept, an adaptable multiple-access algorithm was modeled with MATLAB to predict the channel capacity and to simulate

AMERICAN INTERNATIONAL RADIO, Inc.

Make it easier through A.I.R.



MOTOROLA

Authorized Distributor

To have access to technical solutions in two-way radio systems

To obtain the best service and supply of spare parts and components

To get Motorola products at fair prices

To design, supply and install turn-key systems at the client's request

To fulfill your needs in antennas, duplexers, filters, coax cables, encryption, batteries or any other accessory you require

To receive the best support and to become part of our AIRadioNet team of more than 100 dealers ...
PLEASE CONTACT US !!!

AMERICAN INTERNATIONAL RADIO, INC.

3601 E. ALGONQUIN
ROLLING MEADOWS, IL 60008, USA
TEL.: +1 847 818 9999
FAX: +1 847 818 9190
E-mail: AIR@airradio.net

AGEXIMCO

Bucharest,
ROMANIA

Fax: +40 1 3122364
E-mail: ageximco@radiotel.ro

AIRadioNet

Palma de Mallorca
SPAIN

Fax: +34 971 46 38 54
E-mail: airadio@retemail.es



Circle (19) on Fast Fact Card

how capacity is affected as users change behavior. To model behavior change, I used a variable, the *collision vulnerability window*, that made it possible to assess how the adaptive user protocol affects overall channel capacity. This variable measures the period of possible collision and can be universally applied in any random-access protocol.

The vulnerability window is the key to understanding how a change in user protocol can severely affect a radio's channel capacity. The vulnerability window, a , was defined in the model as the ratio of human PTT activation time ($T_{ptt} \sim 0.2\text{sec.}$) vs. the average idle time between messages ($W \sim \text{many sec.}$), with the equation:

$$a = T_{ptt} \div W.$$

This illustrates to what degree a changing user protocol affects the channel capacity. Outputs from the adaptive user protocol model are graphed in Figure 2 on page 25.

Although an average five-second message length was used in this model, real message lengths vary randomly around that figure, some even lasting 15 seconds or more. In periods of low message load, W is quite large compared to T_{ptt} , and the vulnerability window is nearly zero ($a \sim 0$), meaning almost no vulnerability period exists (no collisions). The tallest curve in Figure 2 shows the throughput characteristics of the 1-persistent CSMA protocol throughput with $a = 0$. The peak channel throughput is at $S_{\max} = 0.54$, meaning that, at best, 54% of the offered load can be passed successfully through the channel. As the message traffic increases, W reduces significantly, and the vulnerability window value grows larger. The second curve, "1-p CSMA," models a channel in an early phase of a high use with $a = 0.4$. The throughput drops to $S_{\max} = 0.38$. Under heavy loads, a nearly continuous vulnerability period is present (many collisions). Consequently, as the load increases, the throughput eventually converges to the pure ALOHA value (dashed line), where the best throughput is only $S_{\max} = 0.18$, with a maximum probability of collisions, and low throughput. This variable, as it turns out, is not so obvious. When radio users forget their good protocol behavior, it degrades the channel's throughput potential. The channel not only suffers from a rise in users trying to get "on the air," but the channel's capacity to handle this increasing load is reduced by the many users who forget their etiquette out of frustration. This is why congestion occurs rapidly during

periods of heavy use. It's like standing on a hose when you're trying to get more water through it.

A word about trunking

In a trunked radio system, especially one with a central control channel, users have no direct impact on the channel capacity. The control channel manages the vulnerability window by providing a protocol buffer between the human operator and the channel. This buffer allows for full capacity use of the channel, minimum throughput delay and no message collisions, especially during heavy use. These are just some of the reasons why trunking provides a more efficient use of the spectrum by providing maximum throughput capacity of channels and preventing users from compromising capacity.

A useful concept

The concept of creating an analogy between the conventional radio channel and a packet data channel, with the radio users as "adaptive protocol machines," is helpful in calculating the maximum throughput capacity that can be expected from a conventional channel. It aids understanding of how maximum throughput of a single channel, during various channel loads, is affected by the adaptability of the users. The concept also illustrates why system users need to learn how to maintain their call etiquette during crisis situations.

The model is helpful in several other ways. It illustrates the underlying

mechanisms of how users directly affect systems, and it is especially valuable in creating a model for predicting the actual changing load and capacity of a conventional multiple-access channel. It also illustrates how, by comparison, trunking can benefit channel efficiency. Finally, it shows that maximum theoretical throughput for a single channel to be about 54% of the offered load. This factor yields a maximum of about five to seven five-second user messages per minute that can be transmitted under a heavy offered user load of nine to 11 five-second messages per minute, which is an example of a busy channel.

Beyond that, if users begin changing their protocol, channel throughput drops rapidly to zero.

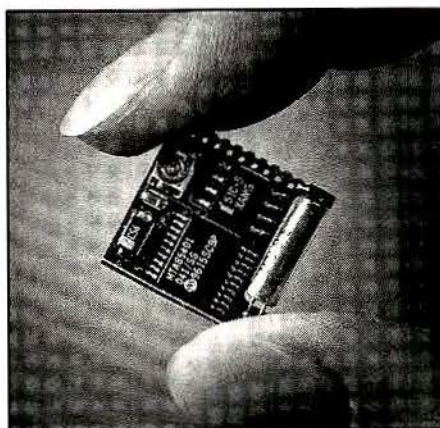
So, how many users can a typical channel support? To find out, determine the parameters of maximum throughput and the probability of user access. With a maximum throughput of about six messages per minute, and a probability of user access of 0.08 (the chance of any user with one five-second message per minute, per user), a single channel could support as many as 75 users. That is:

$$\# \text{ users} = \frac{\text{throughput}}{\text{probability of user access} \times \text{message length}}$$

$$\text{or: } N = \frac{30\text{sec.}}{0.08 \times 5\text{sec.}}$$

It is interesting to note that in the FCC guidelines (47 CFR Part 90.633a), the per-channel loading for non-SMR conventional channels is authorized for a minimum of 70 users. I guess I could have just looked it up. ■

Digital ANI (Unit ID) Motorola® MDC-1200® Format



Micro-Miniature ID-12

Motorola and MDC-1200 are registered trademarks of Motorola Inc.

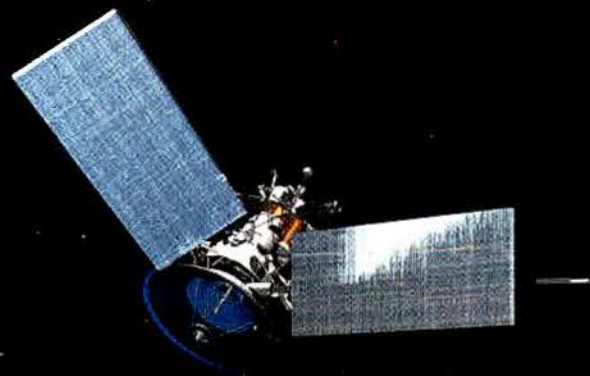
Manufactured by Control Signal®, the ID-12 ANI encoder is a cost-effective way to upgrade all the radios in your fleet with ANI that is compatible with Motorola MDC-1200. Works in all radios, and its tiny size (.59" x .65" x .12") allows it to fit in virtually all hand-holds. Has leading and trailing IDs, emergency, and time-out timer. Fleet price (100 qty) \$89 ea. Dealers: Call for pricing.

Call 800-521-2203

CSC CONTROL SIGNAL

1985 S. Depew, #7, Denver, CO 80227
(303) 989-8000 FAX 303-989-8003
WWW.CONTROLSIGNAL.COM

Satellite communications for public safety



A southern application of satellite communications to rural emergency medical services demonstrates the advantages 'sky repeaters' offer to rural areas.

By Tom D. Soumas Jr.
and Dave Robertson

Satellite communications—once considered an exotic and forbiddingly expensive method of mobile communications—is becoming a viable option for public safety agencies for several reasons. The size, weight and cost of portable and mobile satellite terminals have dropped considerably in recent years, as have the usage costs for the satellite services. At the same time, the range of mobile satellite services has blossomed, with new capabilities such as fax, data, position tracking and dispatch radio becoming readily available at an affordable cost.

This article examines some of the current and projected mobile satellite communications technologies, the range of satellite services available and the cost-benefits of satellite communications for public safety applications.

LEOs and MEOs and GEOs—oh my!

The satellite communications industry is rapidly developing and growing. Industry news reports are full of the fortunes and misfortunes of companies such as Iridium, ICO, AMSC and Globalstar. It can all be baffling for the layperson, who simply wants to get the best products and service at the best price.

We'll start with a quick overview of the different choices in satellite communications. The satellite systems are normally grouped by the height of orbit for the "birds" in space.

► **Low-orbit systems** — Low-earth-orbit satellite systems (LEOs) are relatively small and low-powered. They orbit the earth rapidly. Because they are close to the earth's surface, they do not require as much power. This also means that the mobile transceiver requires only a relatively small omnidirectional antenna. LEO satellites are cheaper to build and to put into orbit. On the other hand, with LEOs you need more satellites to provide global coverage. The switching scheme is more complex because the rapidly moving satellites are constantly having to hand off calls to each other, and a worldwide infrastructure of ground stations is required. Iridium, Teledesic and Globalstar are LEO systems.

► **Medium-orbit systems** — The next group of satellites are medium-earth orbit (MEOs). They are also sometimes called ICOs, for "intermediate circular orbit." With a MEO system, you can cover the earth with fewer satellites, but the higher-powered spacecraft are more expensive to build and to launch into orbit. Spaceway and ICO Global Communications are

both examples of MEO systems.

► **Geosynchronous systems** — Finally, there are geosynchronous satellite systems (GEOs). The GEO systems are based on the premise that a satellite placed in orbit over the equator at precisely the right altitude has an orbital speed exactly the same as the earth's rotation on its axis. This means that the satellite's position in the sky relative to



Why let high noise compromise job site communication? Just add a David Clark Company Noise Attenuating Headset and Radio Adapter Cord to your two-way radio or cell phone and experience crisp, clear communication. You'll also protect your hearing and eliminate the hazard of clumsy and confusing hand signals.

CLEAR COMMUNICATION FOR HIGH NOISE JOB SITES.

- High quality Noise Attenuating Headsets with Certified NRR of 24 dB.
- Over-The-Head, Single Ear or Behind-The-Head style for use with safety caps, helmets, etc.
- Boom-mounted or Throat microphones.
- Voice-Activated (VOX) or Push-To-Talk systems.
- Adapter Cords for over 300 Two-Way Radio models.



Improve safety on the job through better communication.
Test one of our systems on your job site. Call toll-free:
1-800-900-3434



David Clark COMPANY
INCORPORATED

360 Franklin Street, Box 15054, Worcester, MA 01615-0054 U.S.A.

TEL: (508)751-5800 E-Mail: sales@davidclark.com FAX: (508)753-5827

Visit our web site at www.davidclark.com

©1999 David Clark Company Inc.

T-6

Soumas is president of SatCom Systems, Burbank, CA, and Robertson is vice president of Emergystat, Vernon, AL.

a fixed point on the ground will always be the same. This has obvious advantages for fixed antenna systems such as home TV systems. It also has the benefit of being able to offer nearly global coverage with only a few satellites. On the other hand, the orbital distances are such that much larger, high-powered satellites are required, and they are far more difficult and expensive to launch into orbit.

Probably the best-known GEO system in mobile communications is Inmarsat, which was originally created for maritime communications with ships on the high seas. The Inmarsat system has also won a considerable share of the land-mobile market with the latest generation of relatively small briefcase-size satellite terminals. Inmarsat provides worldwide coverage, except for the extreme polar regions.

There are also a number of regional

GEOs, such as the MSAT satellites, over North America, and other similar systems for the Far East, Australia, South America, Europe and Africa. These regional systems typically use spot

Public Safety



beams to maximize power into specific areas.

MSAT-1 is a good example of a regional GEO system. The MSAT-1 satellite is in geostationary orbit at 106.5° west longitude and operates in the L-band frequency range. The footprint of the satellite covers all of North and Central America, extending from the Arctic Circle to the northern portion of Ecuador. The satellite system is operated by TMI Communications, a Canadian consortium. SatCom Systems has been providing MSAT-1 services to the U.S. market under a Special Temporary Authority (STA) from the FCC since July 1998. Full License Authority was granted to the company by the FCC in November 1999. A similar service is also provided by American Mobile Satellite Corporation (AMSC) through the MSAT-2 satellite.

The recent bankruptcies of Iridium and ICO should in no way be taken as a sign that the technology is faltering or slowing down. On the contrary, these pioneering systems have led the way into an exciting new world of mobile communica-

tions, and the prospect of hand-held cellular-like satellite phones is on the verge of becoming a reality. The next generation of satellites, such as Teledesic, will provide a true high-speed data bus permitting wireless Internet and electronic connectivity worldwide.

Meanwhile, back to today

Satellite communications systems (whether they are LEOs, MEOs or GEOs) provide a wide range of services, including voice, fax and data. Other services typically include vehicle tracking and differential GPS data broadcasts for precise positioning. For instance, MSAT-1 users in the United States have a choice of dial-up telephony, fax, circuit-switched data, packet-switched data and push-to-talk (PTT) two-way dispatch radio. The latter service, marketed by SatCom Systems under the trade name NetRadio, is supporting applications in the public safety sector, especially in remote rural areas.

The service uses dedicated satellite channels to provide two-way, half-duplex, point-to-multipoint dispatch communications. Subscribers get unlimited satellite usage at a fixed monthly rate. Functionally, it is identical to a terrestrial, trunked, two-way radio system, with channels, talk groups and familiar PTT microphones. The only difference is that the repeater is some 22,000 miles in space instead of on a tower.

Supporting rural EMS

A glance at any political map of the United States reveals that large portions of the country are thinly populated. Yet, residents of these rural regions rightfully expect that they will have access to the same sort of police, ambulance and fire service as their counterparts in metropolitan areas. This expectation presents a challenge to public safety organizations.

Take, for example, Emergystat Ambulance Service, which operates a fleet of about 65 vehicles across a sparsely populated region of Alabama and Mississippi. Founded in Vernon, AL, in 1988, Emergystat has steadily expanded into a major regional EMS company. Today, the company provides paramedic services for 34 locations in Alabama and Mississippi, with more than 400 employees and 65 primary vehicles. More than 50 of these vehicles are typically in



service at any given time. Cellular and two-way radio coverage is unreliable or unavailable in much of this rural region.

Emergystat recently deployed a NetRadio system, installing satellite terminals on 15 vehicles and one fixed terminal at its dispatch center in Vernon. The units are all tied together in a private, dedicated talk group. Initial results are being evaluated, but it is believed that Emergystat can save more than \$10,000 annually, per location, by switching to the satellite dispatch radio system.

Satellite communications technology will play an important role in Emergystat's plans to expand its business. Every time the company moves into a new location, it can cost more than \$20,000 in capital outlay to set up a mobile radio network, including tower rentals, repeater purchase, leased landline connections and labor—not to mention the inevitable headaches of securing licenses. Many of the towns and counties in this part of the country renew agreements with EMS providers on an annual basis. It is difficult to justify the large capital and operating expenditures needed to establish and maintain modern trunked special mobile radio (SMR) networks for a thin-route area in a competitive marketplace.

The satellite network offers inherent flexibility in fleet management, permitting Emergystat to deploy vehicles rapidly from one service area to another. They can communicate via satellite with the dispatch center in Vernon no matter where they are.

Last year, for instance, when a hurricane hit the Gulf Coast, Emergystat had to deploy a number of vehicles on short notice to evacuate people from hospitals. Much of the time they were not in range of the installed SMR networks and were outside of cellular coverage, so the drivers were often completely out of touch with the dispatch center. This is one time that the satellite networks could literally have been lifesavers.

Not just for rural agencies

The benefits of mobile satellite communications for rural areas is obvious, but important benefits exist for urban areas as well, where satellite systems can provide essential backup for existing terrestrial systems. In a metropolitan area, where there are multiple layers of excellent, modern communications facilities, there is still an inherent vulnerability to disruption from natural disasters, such as earthquakes in California, hurricanes in Florida, ice storms in

Massachusetts and tornadoes in Kansas.

For these places, mobile satellite communications can provide a low-cost backup communications network for disaster relief and recovery. For instance, SatCom Systems deployed a large number of satellite terminals to Honduras and Nicaragua in the aftermath of Hurricane Mitch in 1998. In many cases, this was the only link with the outside world. The U.S. Army Corps of Engineers has been a major user of the system in its rebuilding efforts in that heavily devastated region.

What's next?

Mobile wireless satellite technology is now a practical and cost-effective alternative for public safety communications, but that's just the beginning. In the next few years, as new satellite services such as Iridium, Globalstar, ICO and Teledesic come into service, a large portion of terrestrial communications will migrate naturally to satellites. Moreover, the satellites will open exciting new possibilities for vehicle tracking, asset management, precise positioning and high-speed data transfer. ■

Antenna and Cable

ANALYZERS

The AEA Division of Tempo specializes in hand-held test instruments for the wireless communications industry.

SWR Analyzers

Our commercial line of SWR instruments include: **30-150 MHz**, **140-525 MHz** and **700-1000 MHz**. These quality products give a graphical presentation of the SWR and Return Loss curves for an antenna or tuned circuit under test. Each product includes Windows™ 95/98 applications for saving and printing curves. Each product is priced in the US at **\$599.95**, **\$659.95**, and **\$759.95** respectively, plus \$7.50 shipping and handling.

Complex Impedance Analyzer

For the HF range, we have complex impedance analyzers in the same package as the SWR analyzer products. These products offer virtually all the features of the SWR analyzer products plus many additional features such as **graphical presentation of Impedance, Resistance, Reactance and phase angle curves**. The distance to the nearest short or open in a coax cable can easily be determined. You can tune antennas and most tuned circuits within the frequency range. Call for details.

Cable Fault Locators

AEA offers a complete line of products to give the user the ability to **easily find faults in cables**. Our tone locator systems start as low as \$85.00 and our precision step TDR (Time Domain Reflectometer) product beats any competition at only \$3535.



The **CableMate™** at \$499.95 is the lowest priced graphical TDR available, anywhere. It will **display simultaneous faults** out to 2000 ft. with the best **RF noise filter** known in a TDR. An RS-232 port is standard. The user can store up to 15 plots in the internal memory. Outputs are provided for **coax or twisted pair** cables. An external oscilloscope can be used for enhanced sensitivity.

The new **TR-3120 Step TDR** gives the user **resolution to better than one inch**, with the ability to determine the **impedance of any discontinuity** including connectors and splices. Faults can be spotted in the first inch of cable out to about 4800 ft.

See complete information on these and other products on our website.

www.aea-wireless.com

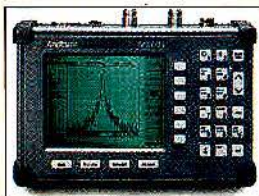


A Division of
Tempo Research Corporation

Phone: (800) 258-7805 or (760) 598-8900
Fax: (760) 598-5634
e-mail: aea@aea-wireless.com
1390 Aspen Way • Vista, CA 92083

*Prices and specifications subject to change

The following pages contain mobile radio, paging and cellular products and services of advertisers in this issue. Information is provided by the advertisers. For more information on these products, circle the corresponding Fast Fact number found on the card on page 57, or contact the advertiser directly. Also, refer to the Advertiser Index on page 56 for the page reference to the company's advertisement.



Spectrum analyzers

Anritsu's MS2711 is a hand-held spectrum analyzer that delivers synthesizer-based performance to ensure accurate, reliable measurements—anywhere, anytime. The analyzer provides spectrum analysis in a lightweight, battery-operated unit covering the 100kHz to 3,000MHz frequency range.

Circle (301) on Fast Fact Card

Hand-held receiver

The Mongoose from Berkeley Varitronics Systems is a lightweight, hand-held receiver that is suitable for quick, indoor sweeps by propagators. It weighs less than five pounds with the rechargeable NiCd battery. The internal memory stores signal strength that can be output to a PC with a serial cable.



Circle (302) on Fast Fact Card

Digital pager

Digipager Wireless from Canamex Communications has an internal, 5W, UHF/VHF synthesized transmitter. The user can page numerically or vibrate pagers from the keypad. The standard RS-232 port receives TAP alphanumeric messages from external sources such as nurse call systems or from other Quikpager input modules.



www.canamexcom.com or 800-387-4237

GP-24

GP-24S

GP-24
2400-2450 MHz
Omnidirectional Antenna
Gain: 15.4dBi
Height: 56 inches
Connector: N-Female
Max Power: 100 Watts
VSWR: Less than 1.5:1
Construction: Collinear 22 1/2 waves,
white FRP radome

GP-24S
2400-2450 MHz
Omnidirectional Antenna
Gain: 9.9dBi
Height: 43 inches
Connector: N-Female
VSWR: Less than 1.5:1
Construction: Collinear 13 1/2 waves,
white FRP radome

CYA-2412
2400-2450 MHz
Directional Antenna
Gain: 15.5dBi
Length: 30 inches
Connector: N-Female
VSWR: Less than 1.5:1
Construction: 12 elements,
grey radome

X2427
2400-2450 MHz
Directional Antenna
Gain: 21dBi
Length: 60 inches
Connector: N-Female
VSWR: Less than 1.5:1
Construction: 27 elements, grey
fiberglass radome



CYA-2412

X2427

WE'RE YOUR INTERNATIONAL SOURCE FOR QUALITY 2.4GHZ ANTENNAS

National Communication Group specializing in maximum gain 2.4GHz Omnidirectional and directional antennas

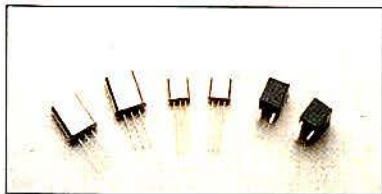
- Professionally Engineered
- Superior Construction
- Phenomenal Performance

For more information please call:

P: 714-630-4541
800-962-2611
F: 714-630-7024


NCG
COMPANY
1275 N Grove Street
Anaheim, CA 92806
www.cometantennas.com

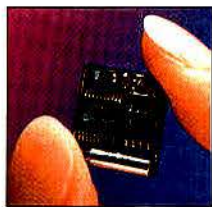
Circle (23) on Fast Fact Card



Crystal filters

Communication Specialists offers low-cost, exact-replacement narrowband crystal filters for 10.7MHz, 11.2MHz, 11.7MHz, 21.4MHz, 21.8MHz and 45.05MHz. For more information, visit the Web site at www.com-spec.com for the complete catalog and product descriptions

Circle (304) on Fast Fact Card



ANI encoder

Control Signal's ID-12 ANI encoder has Motorola MDC-1200 format, pre- and post-ID, time-out and emergency. The ID-12 is tiny (0.59" x 0.65" x 0.12") and works in any radio. Field programming or factory programming is available. Call 800-521-2203 or visit www.ControlSignal.com.

Circle (305) on Fast Fact Card

Headset adapter

David Clark's model C6501 headset adapter is designed for use with all David Clark series 6000 noise-attenuating headsets and Nextel digital cellphones. The adapter features a positive "action-detented listen-level control," mute switch and convenient clothing clip.



800-900-3434



Narrow notch

The **Eagle TNF-400** tunable filters provide <0.7% notch width with notch depths of >30dB. Frequencies available are 10MHz to 500MHz. Units will pass up to 1.0GHz. Package size is 3" x 2". Call for free application note, 520-204-2597.

Circle (307) on Fast Fact Card



Survey meter

The model 8715 survey meter from **Narda** combines ease of operation with measurement capabilities. The meter can also make precise, spatially average measurements critical for the collinear dipole antenna arrays common in modern wireless communication systems.

Circle (308) on Fast Fact Card



Speaker microphone

Otto Communications offers a new option in speaker microphones—the Otto V2-L. Sealed watertight, the series provides premium audio performance at an affordable price and is a suitable choice for those who can accept fewer features to reduce speaker mic costs. It is lighter and slimmer than the standard V2 speaker mic.

Circle (309) on Fast Fact Card



Portable radio

The **Motorola TS11** is now available from **P&W Service Center** with prices starting at \$169.75 for the VHF model. Prices include PL code, battery charger and belt clip. The radio is voice-programmable. The radio is compatible with SP10, SP21, TS10 and Spirit radios.

Circle (310) on Fast Fact Card



A member of
Bird Technologies Group

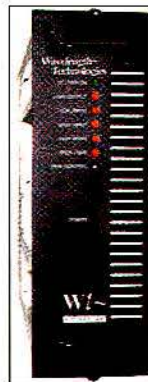
Collinear array antenna

TX RX Systems, a division of Bird Technologies Group, is offering three versions of its broadband collinear array antenna for the 860MHz-960MHz range. Each model is an antenna featuring bandwidth and pattern consistency, along with 1,000W power-handling capability.

Circle (311) on Fast Fact Card

Power amplifiers

Wavelength Technologies' 100W SMR power amplifiers, H10 series, are for 450MHz-470MHz continuous-duty applications. They feature adjustable 10W-100W output, remote status and fault monitoring. They are fully modular and space-efficient, fitting into a 3.5" rack. Call 800-872-6233.



Circle (312) on Fast Fact Card

ITA conference focuses on spectrum management

Regulatory issues affecting private wireless spectrum highlighted the annual meeting of the **Industrial Telecommunications Association (ITA)** and its independent market councils Oct. 27-30. More than 200 owners and users of private wireless systems attended the conference, held at

Washington's Grand Hyatt Hotel.

Highlights of the meeting included a question-and-answer session with Thomas Sugrue, chief of the FCC's Wireless Telecommunications Bureau, an address by senior Motorola executive Robert W. Galvin and the first public announcement of the introduction of the Private



At ITA, WTB Chief Thomas Sugrue displays a fee calculator used in Great Britain.

Wireless Spectrum Act in Congress.

The spectrum legislation, which limits its auctioning of private wireless spectrum and provides for additional spectrum assignment for private business and industrial use, was introduced in Congress concurrently with the three-day ITA meeting by Senators John B. Breaux (D-LA) and Slade Gorton (R-WA). The ITA honored Breaux Oct. 29 during the closing banquet for his outstanding contributions to private wireless.

Sugrue, in the opening conference session Oct. 27, told attendees that the FCC was "not hell-bent to impose an auction regime on the bands that are already encumbered and already in use." He also reported that the notorious backlog of pending licensing paperwork should be resolved by the end of the second quarter of 2000. Sugrue told the audience that "We need some new tools at the bureau," and he described an ongoing comparative review of licensing techniques in foreign countries.

At the closing banquet, 60-year-veteran Motorola executive Galvin praised the service efforts of the National Association of Motorola Service Stations (USMSS), one of ITA's independent market councils, and spoke of the need for comprehensive spectrum policy at the FCC.

Other sessions focused on technical advances in trunking and narrowbanding technology, FCC administrative activities and congressional efforts in the telecom arena. Attendees were also provided with a dedicated exhibition area for the second year running, which included exhibits by more than 25 manufacturers and service providers. **DK**

QUIKPAGER™

Wireless

Professional, Reliable On-Site Paging

Industrial Machinery and other Emergency Equipment Monitoring

Temperature Monitoring

Alarm Monitoring

Standard Features

- VHF, UHF Band; POCSAG.
- Frequency Synthesized or Crystal selection.
- 1, 2, or 5 watts.

Ideal for Hospitals, Factories and other On-Site paging Applications

Standard Features

- 5,000 Pager Capacity.
- Telephone Interface with Voice Prompts.
- Internal Modem for Wide Area Paging.
- Receives messages from other Entry Devices via the telephone line.
- Bidirectional RS-232 Port, TAP Protocol.
- Printer Port for Logs of sent messages.
- Back-up battery to retain programming during power failure.

DigiPager™

Standard Features

- 1 or 5 Watts Synthesized Transmitter.
- Numeric Keypad.
- RS-232 Serial Port for inbound alphanumeric messages using TAP Protocol.

1-800-387-4237
www.pagingwords.com

Canamex Communications Corporation
Tel. (905) 475-5557 Fax (905) 475-5568

Circle (40) on Fast Fact Card

Nothing Beats A...

Quality Means Reliability ...

In today's marketplace, Diversified Electronics, Inc. stands out as the Quality Leader you can always depend on.

Call us for:

- ✓ Motorola Original Radios, Parts & Accessories,
- ✓ Motorola Mag One Line of Products,
- ✓ David Clark Headsets

When you have lives on the line you can't afford to take chances.

Buy the best and pay less from Diversified.

Visit Us On The Web At www.diversifiedelectronics.com



DIVERSIFIED ELECTRONICS, INC.

309-C Agnew Dr.
Forest Park, Georgia 30297

Toll Free: 1-800-646-7278 Ext. 144 Fax: (404) 361-6327 Ext. 144



Circle (24) on Fast Fact Card

CAD systems target small agencies

Oklahoma City-based Global Dispatch Technology continues to address the small- to mid-sized agency public safety market for computer-aided dispatch (CAD). At the November International Chiefs of Police Show in Charlotte, NC, Global unveiled its Dispatch Express system for 9-1-1 and dispatch centers serving populations of less than 100,000.

The system allows communities to uniquely identify equipment and employees. Communities can also define response districts and custom-configure information such as nature of incident, unit type, unit classification and alarm level. A single-screen display provides unit time stamping and call status. If an E9-1-1 has been completed, the system automatically fills in caller identification data. Optional interfaces to alphanumeric pagers, RMS and state NCIC databases are available. An early adopter of the system is the Clear Lake Emergency Medical Corps, Clear Lake, TX.

Simon Aleman Jr., Global founder and vice president of marketing, said the new system is a scaled-down version of the company's CAD Assist program. Mapping functions and GIS information have been removed because some small agencies either cannot afford or simply don't require such displays to operate effectively. Aleman called the system an "entry-level product" that allows dispatchers to match geographic codes with electronic "box cards" for response plans. A system with an RMS option can be installed for less than \$30,000, he said.

Global's recent contract awards include placing its PSAP Map system with the Sumner County, TN, Emergency Medical Services. Its CAD Assist system recently has been adopted by the Hancock County, IL, Emergency Telephone Systems Board and by the city of Saginaw, TX, for police dispatch. DK

100 AMPS CONTINUOUS



MB 100M Power Supply from DuraComm

13.8 VDC Output Rated at 100 amps continuous duty in a package that fits a standard rack, is only 3 1/2" tall and meets "half rack" depth requirements.

- 3 Other Models available, starting at 40 Amps Continuous
- Modular, expandable construction
- Dual thermostatically controlled cooling fans
- Battery back-up module available for UPS

Join DuraComm in the switch-mode revolution!
Contact your communications distributor
or call or fax us Toll Free.

Phone 1-800-467-6741 Fax 1-800-825-1403

DuraComm®
CORPORATION

203 W. 23rd Ave.
North Kansas City, MO.
64116

On the Web at www.duracomm.com
e-mail: duracomm@duracomm.com

Circle (25) on Fast Fact Card

ICING PROBLEMS?



Telewave antennas are designed to survive the most demanding winter conditions, and deliver top performance where others fail.

Our new Tegi models feature our exclusive black radome, which nearly eliminates ice buildup.

Our new Tegi models feature our exclusive black radome, which nearly eliminates ice buildup.

FiberStar antennas feature our "Cool Blue" radome, enclosed base, and industry standard Type N or 16 DIN connectors.

Call 1-800-331-3396 today to find out how Telewave can meet your requirements, or visit us at www.telewave.com



Telewave Open Dipole antennas in Alaskan FM translator service.



TELEWAVE, INC.

1155 Terra Bella Avenue • Mountain View CA 94043

Circle (26) on Fast Fact Card

FCC Notes

The FCC reorganized its bureau structure at the end of 1999 to create a new **Enforcement Bureau**, consolidating activities within the Common Carrier, Mass Media, Wireless Telecommunications and Compliance and Information Bureaus. The Enforcement Bureau comprises four divisions: Telecommunications Consumers; Market Disputes Resolution; Technical and Public Safety; and Investigations and Hearings. The new bureau will also manage the commission's regional and field offices in charge of investigations, inspections and audits. Chief of the new bureau is **David H. Solomon**, formerly with the General Counsel's Office.

The FCC has allocated 75MHz of spectrum as part of the U.S. Department of Transportation's **Intelligent Transportation Systems (ITS)** national program. The 5.850GHz-5.925GHz band will be used for Dedicated Short Range Communications (DSRC) applications, such as traffic light control, travelers' alerts, emergency vehicle override of signals and electronic inspection of moving fleet vehicles.

The announced schedule for the 929MHz and 931MHz **paging service auction** calls for a Form 175 filing deadline of January 20. Upfront payments are due February 7. Orders for remote bidding software must be placed by February 11. A mock auction will be held on February 22, followed by the real thing on February 24.

Radio Frequency Systems reorganizes

Radio Frequency Systems is consolidating two formerly separate divisions into one operation.

The new company merges, on a global basis, the product lines of the former RFS and Celwave groups. It has manufacturing, distribution, sales and service operations in Europe, North America, South America, Australia and China.

For North and Latin American customers, this change means combining Cablewave and Celwave product lines into one division to be known as RFS America. RFS America, with headquar-

ters in Meriden, CT, will be led by Richard Tallon, previously president of Celwave. RFS America will be responsible for markets in the United States, Canada, Mexico, Central America, the Caribbean and northern South America.

Other regional divisions of the new global company will be located in Australia, Brazil, Germany and China.

George Gigas, previously president of Cablewave, will take up the global Radio Frequency systems corporate function of technical director.

AMTEX offers new directions for SMR operators

AMTEX 99, held in conjunction with IMTEX, featured 17 exhibitors and about 100 registered attendees. The conference and exhibition was held Nov. 15-16 at the Hilton in the Walt Disney World Resort in Orlando, FL.

Sessions throughout AMTEX focused on new revenue opportunities for dealers and operators. Randy Wilgis, vice president of dealer and VAR markets for TESSCO, presented the first session. "Over the past year, I've talked to a lot of you, and the No.1 thing you're concerned about is where your business is

going in the next few years," Wilgis said. He suggested that SMRs offer integrated solutions that might include LAN, video and Internet service as well as traditional voice.

Steve Virostek, formerly vice president of messaging and dispatch for Strategis Group, presented the "2000 State of SMR & Digital Mobile Radio Market Report" in the closing session, concluding that wireless carriers are re-addressing the business market for voice and data services, with third-generation technology looming on the horizon. NC

REPEATER, PAGING & BASE AMPLIFIERS

200 w. UHF Amps under \$1000!

250 w. VHF Amps under \$800!

Why Pay More?

For over 20 years, Henry Radio has been manufacturing low cost, reliable mobile amplifiers. All common brands, power ratings and configurations are available.

Call today for specifications and prices or visit our web site:
www.henryradio.com

1.800.877.7979



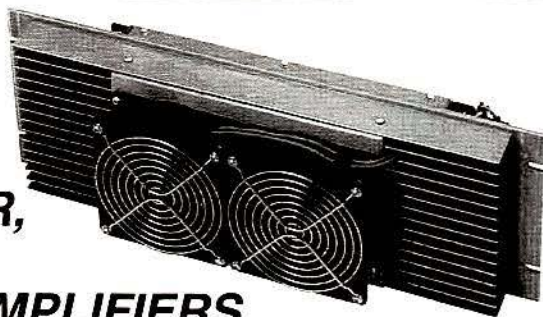
HENRY RADIO

2050 S. Bundy Drive, Los Angeles, CA 90025

Phone: 310.820.1234 FAX: 310.826.7790

www.henryradio.com

Circle (27) on Fast Fact Card



Receive Weather Alerts Automatically

on your 2-way radio system,
PA system, voice-mail,
numeric pager or telephone!

- Rack-mount and mobile systems
- Warnings digitally recorded for DTMF access and playback
- Designed specially for demanding Public Safety use

Call toll free 1-888-877-8022
or visit our Web site at:
<http://www.thuneagle.com>



U.S. Patents 5,444,433 - 5,574,999 - D,377,795

Circle (28) on Fast Fact Card

Go to www.mrtmag.com for more land mobile radio news

Find the stories behind these headlines at www.mrtmag.com/editorial/news.htm:

Project 25 approves TETRA standard for private mobile radio

Project 25 has approved the TETRA standard as a Phase II option for future public safety applications in the United States.

International delegates gather in Amsterdam for second TETRA World Congress

TETRA event attracts record attendance for 2nd World Congress.

IMTA announces name change, expands mission

Recently renamed IWTA, the association embraces new areas of business wireless.

ComSpace chooses Hitachi as global OEM DC/MA radio supplier

ComSpace signs Memorandum of Understanding with Hitachi Denshi.

Baltimore launches fully digital communications systems

City officials and Motorola representatives tour city's new communications center and 800MHz Astro system.

Colorado begins Phase II of statewide digital upgrade

Next phase will enhance communications for public safety agencies in Denver, its suburbs and the metropolitan areas of Douglas and Jefferson Counties.

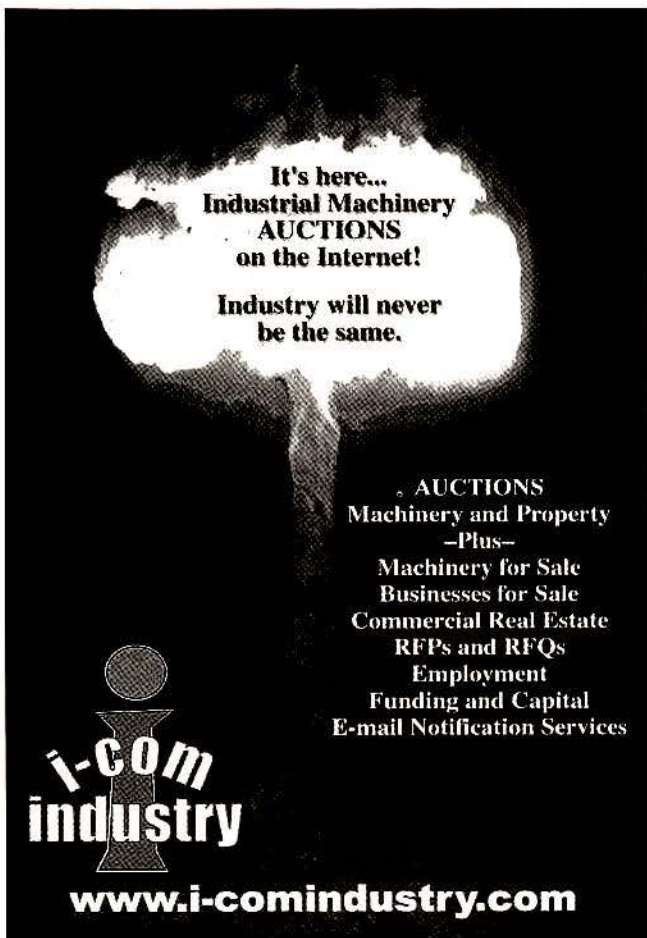
Clermont County initiates construction of \$10.6 million Motorola system

Countywide system includes an 800MHz Astro Smartzone trunked two-way radio system, a Private Datatac wireless data system and an alphanumeric paging system.

FCC diverts paging control channels for San Mateo public safety system

"San Mateo will now be able to build a first-class public safety system," said Art McDole. "The FCC has recognized the edicts of the Communications Act and Congress and placed the priority of public safety first."

Also, read the entire transcript from senior Motorola executive Robert W. Galvin's presentation at the ITA conference held in October.



**It's here...
Industrial Machinery
AUCTIONS
on the Internet!**

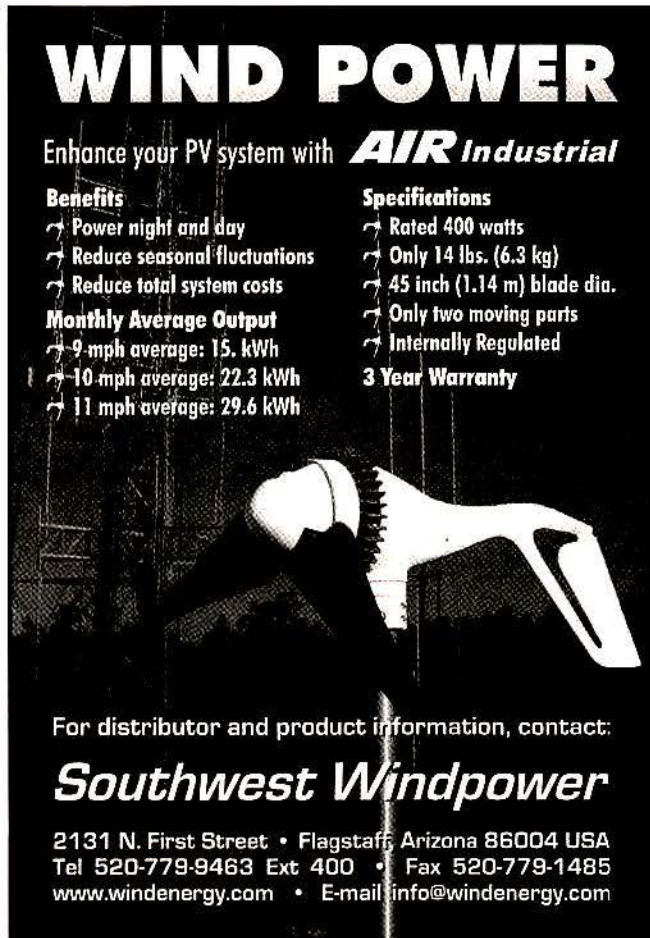
**Industry will never
be the same.**

AUCTIONS
Machinery and Property
-Plus-
Machinery for Sale
Businesses for Sale
Commercial Real Estate
RFPs and RFQs
Employment
Funding and Capital
E-mail Notification Services

**i-com
industry**

www.i-comindustry.com

Circle (29) on Fast Fact Card



WIND POWER

Enhance your PV system with **AIR Industrial**

Benefits	Specifications
➤ Power night and day	➤ Rated 400 watts
➤ Reduce seasonal fluctuations	➤ Only 14 lbs. (6.3 kg)
➤ Reduce total system costs	➤ 45 inch (1.14 m) blade dia.
Monthly Average Output	➤ Only two moving parts
➤ 9 mph average: 15. kWh	➤ Internally Regulated
➤ 10 mph average: 22.3 kWh	3 Year Warranty
➤ 11 mph average: 29.6 kWh	

For distributor and product information, contact:

Southwest Windpower

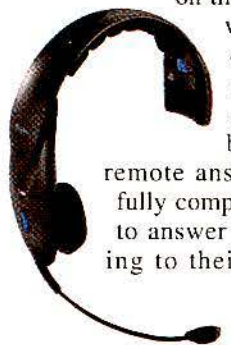
2131 N. First Street • Flagstaff, Arizona 86004 USA
Tel 520-779-9463 Ext 400 • Fax 520-779-1485
www.windenergy.com • E-mail info@windenergy.com

Circle (30) on Fast Fact Card

Headsets

Cordless headset works with any phone

Hello Direct's Cordless XLT features the Hello Direct-developed Learnit smart chip technology, which makes it simple to set up. It does not require manual configuration and is guaranteed to work with any analog or digital phone on the market. The headset



Circle (351) on Fast Fact Card

weighs six ounces, including either the standard four-hour or an optional nine-hour battery. The Readline remote answering accessory is fully compatible, allowing users to answer calls without returning to their desks to lift their handsets. The headset operates at the 900MHz frequency.

Headsets offer noise-canceling microphone

Sigtronics' SE-48 and SE-8 headsets are noise-attenuation headsets with flex boom-mounted noise-canceling microphones. The SE-8 headset can be used with or without helmets. A portable radio adapter connects between the headset and a portable radio and al-

lows two-way radio communications via the headset. The adapter consists of a belt clip box, which contains a radio push-to-talk switch, a standard headset jack, a portable radio interface cable and interface electronics.

Circle (352) on Fast Fact Card

Headsets support car racing apps

The Cleartrak headset from Otto Communications was originally designed for car racing applications. It offers durable, heavy-duty construction to withstand harsh elements. It also features high-clarity sound from the first-systems check to after the final lap. It provides racing pit crews, driving teams and racetrack management reliable, consistent communications for the entire race day. The headsets feature a certified

noise reduction rating of 24dB, extreme noise-cancellation and an electret boom microphone with windscreen. It has a behind-the-head style and comfortable, cloth-covered ear seals. It also offers a flexible coil cord.



Circle (353) on Fast Fact Card



Motorola Fire Pagers



Pager batteries and parts



Tone Filters and Reeds



Portable Radio Accessories

Specializing in:

Pager repairs

Frequency Changes
Minitor II Scan Boards
Keynote Monitor Boards



Call the experts for all your Paging Needs

800-822-2180

Fax: 561-683-0059

International: 561-683-0022

1300 N FL Mango Rd #26

West Palm Beach, FL 33409

<http://www.pwservice.com>



Minitor III and KeyNote are a reg. trademark of Motorola Inc.

Circle (31) on Fast Fact Card

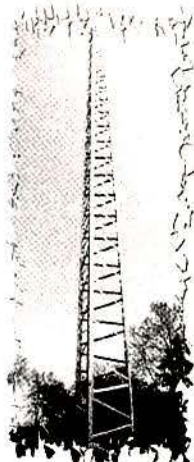
TRYLON TITAN

Self-supporting towers
Up to 96 feet-

only \$1974⁰⁰

Perfect for
wireless LAN
or any
communications
application

Lease this
tower for as
little as \$72⁰⁰
per month



**CHAMPION
RADIO PRODUCTS**
(888) 833-3104

UpTheTower@aol.com
www.championradio.com

Circle (32) on Fast Fact Card

UHF radio, transmitter integrates into headset

The TC917 from **CeoTronics** is a UHF radio transmitter and receiver integrated into a headset. The headset can be operated on one frequency or on two frequencies with 10-channel capability between 433MHz and 470MHz. It can also be programmed to be used with users' existing frequencies and systems. The transmitter is activated manually by a push-to-talk button or by voice (vox). The wearer has total hands-free commu-

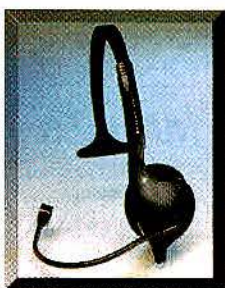


nication. Different versions are available; e.g., with additional ASR (ambient sound reception), with a helmet attachment, as a one-way communications system with one transmitter and several receivers, as a lightweight headset with external transceiver unit or in connection with interfaces to cable bound intercom systems. An intrinsically safe version for use in areas with explosion hazard is available.

Circle (354) on Fast Fact Card

Headset improves intelligibility of incoming calls

The Noisebuster cellular headset from **Noise Cancellation Technologies** can improve the clarity and intelligibility of received communications.



The product features active noise cancellation technology, which electronically reduces ambient low-frequency background noise so

that the user can hear an incoming call more clearly. The headset features active noise reduction (ANR),

which is the electronic coupling of a noise wave with its exact mirror image to cancel the noise. A microphone in the headset's earpiece senses background noise at the user's ear. That information is sent to an electronic controller where an "anti-noise" wave is generated and coupled with the offensive noise to cancel it. The headset is designed for comfortable extended wear and is foldable for easy storage. It features a fully adjustable headband for fit and comfort; a soft leatherette, replaceable ear cushion; and a flexible, swiveling boom for correct positioning.

Circle (355) on Fast Fact Card

Headset suits active environments

The ParMar-Low on-ear headset, model HD-PWH6100, from **TwitCo Distributing**, is lightweight and low-profile. The headset does not interfere with any type of headgear, yet is secure enough to use in active environments such as SWAT and search-and-rescue operations. The headset is shipped with small, medium and

large ear molds. It is appropriate for those who require additional stability in active environments.

Circle (356) on Fast Fact Card



Headset completes swimmer's kit



The Occasional Swimmer's Kit from **Television Equipment Associates** consists of a radio container, a push-to-talk switch and a headset. The

kit is designed for rescue, lifeguard, boating and special operations users who require waterproof radio communications. Both the radio and headset will be protected from saltwater to a depth of 66 feet. The headset consists of an earphone enclosed in a nylon housing and a flexible boom arm dynamic microphone. It will not fall off in white water as it is held on the user by an elastic strap with a touch fastener. The headset has a slim profile for compatibility with helmets.

Circle (357) on Fast Fact Card



1) DLC specializes in installation hardware, including terminals, screws, fuses and fuse holders, cable ties,

battery terminals, relays and more to make your mobile radio install a breeze.

Why DLC

2) Muth Safety Signal Mirrors are hot and available for a wide variety of vehicles including the Ford Crown Victoria



3) Crimping tools, wire strippers, electronic pliers and cutters, soldering irons, and a variety of multimeters and test equipment.



4) A 48 page flyer with a New Products section coming in each issue.



5) Quick off the shelf delivery

6) Rapid response to domestic and export orders and inquiries

7) Order by phone on our 24 hour fax line.

8) We have an experienced sales staff ready to help you with your orders or questions.



**is
your
First
Source**

**FOR ELECTRONIC PARTS
AND ACCESSORIES**



**DAVID LEVY
COMPANY, INC.**

ELECTRONIC PARTS AND ACCESSORIES
12753 Moore Street • Cerritos, CA 90703 • U.S.A.

NATIONWIDE/CANADA
(800) 421-3536
ORDER FAX
(800) 421-3538
LOCAL
(562) 404-9998

FAX
(562) 404-9698
CUSTOMER SERVICE
(800) 962-4120
E-MAIL
dlcbw@aol.com

Circle (33) on Fast Fact Card

READERS' CHOICE

Of the new products in the May 1999 issue, this one generated the biggest reader response. For more information on this product, circle the corresponding Fast Fact Card number on the card found in the back of this issue, and mail the card to us.

Portables offer safe versions



The compact, rugged VX-400 series of land mobile portables from Vertex Radio Communications is available in VHF A, 134MHz-169MHz; C, 148MHz-174MHz; and UHF, A, 400MHz-430MHz; D, 450MHz-485MHz; F, 485MHz-512MHz. The portables meet MIL-STD 810 C/D/E ratings and are available in intrinsically safe versions. VHF and UHF versions feature a full 5W RF power output rating with low-power level settings of 2.5W, 1W and 0.1W. DCS/CTCSS is programmable by channel as well as by 12.5kHz and 25kHz channel spacing. The portables are capable of 16 channels (8 + 8) and offer several scan modes.

Circle (500) on Fast Fact Card

Software extends radio system

Catalyst Communications Technologies' product for secondary dispatch, called Network Access Radio, extends an existing two-way radio system by allowing office workers to talk to field radios via a multitasking PC. The intuitive graphical user interface makes radio communications simple for the casual user. Circuit costs can be reduced because voice is routed over a LAN or WAN using voice over IP for a wide-area dispatch system and distributed in-building coverage. Multiple-office PC users can monitor the same talk group or channel. Each office PC can monitor multiple geographic regions or talk groups or channels. The product can reduce system downtime and technician support time when used to place test calls from a central location.



Circle (401) on Fast Fact Card

Mobile radio features DC/MA tech



The Odyssey series of mobile radios from ComSpace features DC/MA technology, which offers as much as an eight times increase in capacity over traditional 25kHz analog FM systems. This technology is a

combination of QAM, FDMA, TDMA and TDD, giving the user digital technology that meets all FCC refarming mandates, while providing a one-channel-at-a-time migration. The radio features LTR trunking and 32 systems with 250 groups per system. It has a two-line vacuum fluorescent display with 20 characters per line and standard scrolling capability. Direct frequency assignment adds channels without reprogramming radios. The "system busy" queuing offers tone and display notification of available channels. There is an AMBE+ vocoder from DVS included.

Circle (402) on Fast Fact Card

CAD program enhances efficiency

HTE has launched a Microsoft Windows NT-based computer-aided dispatch application called CAD V for police, fire and emergency medical services. The product can work independently or as part of HTE's complete public safety suite. The product can reduce dispatcher workload and enhance communications center efficiency by integrating mobile data computers, E9-1-1, state and federal interfaces, and alarm panels. It also provides dispatchers the flexibility to control all law enforcement, fire and EMS vehicles from one computer screen or multiple displays. CAD V reduces dependency on one central computer by using client-server processing to distribute workload. Without using radios, officers can obtain an array of data in their vehicles. The integrated mobile data terminal/laptop computer capability enables them to run inquiries, receive copies of dispatch/location information and update their status.

Circle (403) on Fast Fact Card

VOCOM



RF POWER AMPLIFIERS

MODELS AVAILABLE:

- ◆ VHF 130-175 MHz to 500 watts output
- ◆ 230-280 MHz to 100 watts output
- ◆ UHF 400-512 MHz to 350 watts output
- ◆ 800-960 MHz to 200 watts output



847-593-1213
FAX 847-593-1320
sales@vocomrf.com
www.vocomrf.com



Circle (42) on Fast Fact Card

Fire alert system reduces stress

First-in from Westnet is a fire station alert and monitor system that can reduce response time and lower stress levels on fire department employees. The system is activated by CAD, radio or phone-line input. This eight-zone system separates the dormitory environment of a multicompany station into

operating zones based on assignment, allowing for selective alarming. It is compatible with all current alarm methods and can be adapted to new technology.



Circle (404) on Fast Fact Card

Battery replaces Motorola XTS

W&W Manufacturing has added the replacement battery for the Motorola XTS 3000 to its product line. XTS batteries are available in the following capacities: WC-061H-8294A, NiCD, 7.5V at 1,700mAh; HC-061HM-8929AM, NiMH, 7.5V at 2,000mAh; HC-061H(S)M-8299A(S)M, NiMH, 7.5V at 2,700mAh; and HC-061H(S)(S)M-8922A(S)(S)M, NiMH, 7.5V at 4,000mAh. Batteries and battery eliminators are also available.



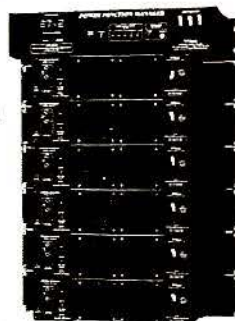
Circle (405) on Fast Fact Card

Communication Power With Amazing Versatility

NEWMAR's Power Module/Power Function Manager – So versatile you can customize a fully integrated and economical power system using off-the-shelf components.

Power Module configuration choices:

- 12, 24, 48 VDC output: positive, negative or floating ground
- 560 or 1000 watts per module
- Parallel or N+1 configuration
- Power supply or charger function
- Charger options: three step charging, equalization, temperature compensation
- Local - remote: control/alarm



Power Function Manager

- Single component merges, monitors & controls Power Modules
- Parallel tie point for power modules
- Digital voltage/current monitoring
- Summary alarm contacts and status lights for remote/local monitoring
- Low voltage disconnect protects load and batteries
- Output bus plus three isolated distribution circuits

NEWMAR®

Newport Beach, CA
Ph: (714) 751-0488
Fax: (714) 957-1621
www.newmarpower.com

Circle (36) on Fast Fact Card

5TH ANNUAL
CONFERENCE
& EXPOSITION

**NATE
2000**

FEBRUARY
15-18, 2000



NATE 2000

is where you need to be!

**The Premier Event in the
Telecommunications Industry!**

**SHERATON SAN DIEGO
HOTEL & MARINA**

**1380 Harbor Island Drive
San Diego, California 92101**

**Hotel Reservations:
619-692-2285**

For more information contact:

National Association of Tower Erectors

420 4th Street NE, Suite 109

Watertown, South Dakota 57201-2699

Tel: 888-882-5865 or 605-882-5865

Fax: 605-886-5184

www.natehome.com E-mail: nate@natehome.com

KEY DECISION MAKERS

TECHNICAL EXPERTS

TRENDS IN THE INDUSTRY

FOCUSED EXHIBITOR PROFILE

LATEST INNOVATIONS

MEETINGS

EDUCATIONAL SESSIONS

LUNCHEONS

RECEPTIONS

NETWORKING

All This and More!

Circle (35) on Fast Fact Card

D.T.M.F DECODER

For interconnect and remote
control applications

The Model
NC401 is a
micro-
miniature
DTMF
decoder,
designed for
selective control of local
or remote applications.



Model
NC401

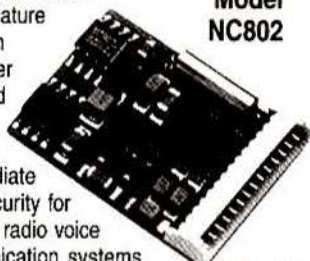
\$59.95

Measuring .80"W x 1.37"L x .23"H, the NC401 combines three distinct, multi-addressing decoders offering multiple user-configurable functions. All programmed features are stored in non-volatile E2PROM memory and are easily programmed by means of a conventional DTMF encoder or the Model NC500 Universal/P.C. programmer. This highly engineered decoder is ideal for portable radio applications having limited space for accessories. The NC401 comes complete with micro-miniature 14 pin header and 12" color coded cable assembly.

Nor-fax Doc. #5545

VOICE SECURITY ENCRYPTION

The Model NC802
is a miniature
inversion
scrambler
designed to
provide



Model
NC802

\$59.95

intermediate
level security for
two-way radio voice
communication systems
and is a perfect, cost-effective
solution to entry-level voice scrambling
as a defense against unauthorized or
casual listeners. The NC802 provides
eight user selectable carrier codes
commonly used by other manufacturers
and interfaces easily to most radios with
near transparency to the user

Nor-fax Doc. #5759

For Detailed Specifications or Product Catalog
call our 24-Hour NorFax retrieval system at
530-477-8403, Email: info@norcommcorp.com or
our website: www.norcommcorp.com



15385 Carrie Dr., Grass Valley, CA 95949 USA

Circle (34) on Fast Fact Card

Antenna offers system flexibility



TX RX Products' broadband collinear array base station antenna offers system flexibility and pattern control in a light-weight, compact structure. A true corporate-feed design, this omnidirectional antenna has been granted two patents. One model covers the entire 450MHz-512MHz band and is available with 0°, 3° and 6° downtilt, as well as with 7/16 DIN or N-type connectors. This antenna is rated for 1,000W of continuous power with a 7/16 DIN type connector or 500W of continuous power with the N-type connector. The solid core

construction provides for a rated wind velocity of 150mph with a maximum tip deflection of 5°.

Circle (407) on Fast Fact Card

Replacement battery housed in slim case

The JB-7143 from JBro Batteries is a 7.5V, 1,200mAh NiCd battery. The original JB-7134 is now available with the same components, but it is housed in a slim plastic case with contoured edges

that match the original manufacturer version. The battery is a replacement power source for the Motorola MT2000, HT1000 and the MTX8000 radios.

Circle (408) on Fast Fact Card

Phone console connects 210 lines

The Positron IAP Plus is a fully integrated 9-1-1 telephone console with programmable feature keys that allow access to emergency and telephone lines, index and speed dials and control functions. A single cable connects the console to the backroom equipment for as many as 210 lines. The emergency call queue places only incoming emergency calls in a queue and allows a call-taker to answer them in the order they were received. The abandoned call indicator alerts the call-taker to abandoned calls prior to answering. The single-button redial of a disconnected caller is made possible through the rerouting abandoned caller option.

Circle (406) on Fast Fact Card

Need Remotes?



Call us.



DC Remotes
DC Termination Panels
Tone Remotes
Tone Termination Panels
Local Extensions
Multi-Channel Remotes



941 Hensley Lane • Wylie, TX 75098
Voice (800) 869-9128 • Fax (888) 437-5360

Circle (37) on Fast Fact Card



Reserve your spot in the next issue!

Phone: 913-967-1861

800-347-9375

Fax: 913-967-1735

Mail: 9800 Metcalf Ave.,
Overland Park, KS 66212



Dawn Rhoden
Classified Advertising
Manager

Category Index

Business for Sale	55
Computer Software	54
Employment	45
Equipment For Sale	46
Professional Consulting Services ..	54
Professional Services	43
Rentals	55
Repair Services	55
Tower Space	55

professional services

FREDERICK G. GRIFFIN, P.C.



3229 Waterlick Road
Lynchburg, VA 24502
(804) 237-2044

NATIONWIDE COMMUNICATIONS CONSULTING
Mobile Radio, Microwave, E9-1-1,
CAD, Paging, LAN,
Dispatch Communications Centers
Multi Site Propagation Analysis

HERB SACHS, CONSULTING

Specialist in Public Safety Communications

P.O. Box 729
Bowie, MD 20715
301-464-4268

MCCON

Mobile Communications Consulting
S.R. McConoughey, P.E.
Principal

13017 Chestnut Oak Drive
Gaithersburg, MD 20878 (301) 926-2837



OMNICOM, Inc.
COMMUNICATIONS ENGINEERING

GENE A. BUZZI
PRESIDENT

930 THOMASVILLE ROAD, SUITE 200
TALLAHASSEE, FLORIDA 32303
PHONE: (850) 224-4451 • FAX: (850) 224-3059
E-mail: omnicon@polaris.net



SCHWANINGER & ASSOCIATES
Attorneys at Law

Robert H. Schwaninger, Jr.

1835 K STREET, NW, SUITE 650
WASHINGTON, D.C. 20006
(202) 223-8837
rs.h.schwaninger@sa-lawyers.net



Let us put YOUR business
card here. Increase your
visibility in the mobile
communications industry!

TROTT
COMMUNICATIONS GROUP

RAYMOND C. TROTT, P.E.
Chairman

1425 Greenway Drive, Suite 350
Irving, Texas 75038
972/580-1911 • Fax: 972/580-0641

PORTA-TECH

PORTABLE
TECHNICAL
SERVICE, INC.

121 Crowell Lane • Lynchburg, VA 24502

GE Portable Radio Service Depot
Factory Approved Nationwide
FACTORY TRAINED TECHNICIANS FOR QUALITY SERVICE
• Current Product Lines
• Voice Guard Certified
• Public Service Trunking
• Surface Mount Technology
ERICSSON
(804) 239-3049

THE PORTABLE DEPOT, Inc.
KEEPING AMERICA COMMUNICATING FROM COAST TO COAST



- FACTORY TRAINED TECHNICIANS •
- SURFACE MOUNT TECHNOLOGY •
- FACTORY APPROVED NATIONWIDE •
- EDACS & AEGIS •
- VOICE GUARD CERTIFIED •

• MPD, MPA, TPX, PCS AND ALL CURRENT PRODUCTS •
Route 2, Box 338C • Lynchburg VA 24501
ERICSSON 804-237-3427

Temp RF Tech Available

\$750/wk plus travel/expenses, lower 48.
EE Degree, FCC Licensed.
15 years RF experience: HF, LB, VHF, UHF.
Pager, Portable, Mobile, Base/Repeater.
Contact Tom at Dixicom.

1-800-207-0122



**Fishing
for new
customers?**

**Try MRT
Classifieds!**



GE PORTABLE SERVICE

- FAST TURN
- WARRANTY
- \$48.00 hr./2 hr. MAX
- PARTS GE LIST
- RETURN UPS PAID



Smith Communications Service
2121 W. Parrish Ave., Owensboro, KY 42301
270-683-0936



ARE YOU READY?

For RF Safety Compliance?...
Before Sept. 1, 2000



Check Out Our Website...
www.RFMeasurements.com

RF MEASUREMENTS, LLC
"The only name you need to know"



**Sell your products FAST!! Advertise on the MRT web site
www.mrtmag.com. Call Dawn Rhoden for details.**

Public Safety Wireless Technology Decisions?



Wireless & Information Technology Consultants

Today, Public Safety Officials face major decisions in selecting which wireless and information technologies will best serve agency needs today and in the future. QRC is the first step in identifying the right solutions.

At QRC, we provide competent, unbiased technical advice concerning the full range of available technologies to support your critical public safety missions.

QRC's approach is simple yet effective: We work with your staff to define your agency's needs, and then identify candidate technological solutions.

QRC is ready to assist your agency throughout the entire life cycle of your public safety technology project—from the planning of a new communications center through the implementation of digital trunked radio system, E911, CAD, and records automation.

QRC provides expert technical and programmatic support in:

- Budget Planning and Execution
- Cost/Benefit Analyses
- Technology Evaluations
- System Specifications, Planning, and Design
- System Implementation Oversight
- Training Program Development
- System Troubleshooting and Optimization

Does your agency require privacy protected wireless communications? Is the security of your information and databases important? Do you need mobile computing today or in the future? Is NCIC 2000 right for your agency? Should you implement a Project 25 digital wireless system? How can commercial wireless services leverage your agency's limited financial resources?

QRC will work with your agency to address these questions and other technology issues in all areas including:

- Integrated Digital Voice and Data Technologies
- Emerging Wireless Technologies
- Project 25 Digital Communications Systems
- NCIC 2000 Technologies
- Commercial Services, such as CDPD and 3G Wireless
- Trunked, Conventional, and Rapid Access Trunked Systems
- Simulcast and Mobile Computing
- Communications Operations Center Design
- Coverage and Propagation Studies
- Enterprise Networking
- Intelligence Analysis Automation
- Information Security and Privacy Protected Systems
- Surveillance and Title III Technologies

For information on how QRC may assist your agency in its Public Safety Technology decision process, contact us at: Quantum Radionics Corporation, 2121 Eisenhower Avenue, Suite 200, Alexandria, VA 22314, Voice: 703.684.8548; Telefax: 703.684.9505; e-mail us at info@quantum-radionics.com or visit us at www.quantum-radionics.com

- Advancing Technology Through the Millennium -

© Copyright Quantum Radionics Corporation 1999

Circle (117) on Fast Fact Card

COME HOME TO AKRON, OHIO!!

B&C COMMUNICATIONS/MOBEX

EXPERIENCED 2-WAY
TECHNICIAN

EXCELLENT BENEFITS
& SALARY

330.773.5129

TWO-WAY RADIO TECHNICIAN

First Communications, Motorola Wireless Technology Center, has immediate openings in our South Georgia and North Florida locations. Qualified candidates must possess the ability to effectively communicate with fellow employees and customers, work without direct supervision and be a self starter. Must be willing to be on call and attend factory training courses at company expense. Must have experience in the installation and repair of Motorola communications equipment/systems and have basic hand tools. FCC license or NABER certification a plus. Salary commensurate with experience, excellent benefits packaging including 401K, paid healthcare, vacation and sick time. If you would like to be considered for this opportunity, send resume to:

First Communications
Attention: Personnel
P.O. Box 2234
Tallahassee, FL 32316
Fax: (850)575-2870
E-mail: edw@firstcomm.net

Two-Way Radio/Pager Technician

Located in the beautiful mountains and countryside of the Northern Shenandoah Valley of Virginia!

Motorola MSS for over 25 years, is seeking a technician with the abilities to install, maintain and repair Motorola equipment. This consists of mobiles, portables, repeaters, base stations, dispatch consoles, pagers and trunking equipment. Repair to component level a must. Ability to use various types of service monitors, meters and computers is a requirement. Must be able to work with others and independently. Salary is commensurate with experience [minimum 2 yrs.] and qualifications. Excellent benefit package with health insurance and retirement.

Join the BEST in Northern Virginia!

Fax resume to (540) 723-6653
E-mail resume to: vtw@visualink.com
Equal Opportunity Employer

MRT
Advertising
that Works
Classifieds

COMMUNICATIONS ENGINEER for City of Youngstown, Ohio

Step I salary - \$39,582.00. Competitive civil service examination will be given on January 22, 2000 in Youngstown, Ohio. Successful applicant must have at least four (4) years of experience installing, maintaining and servicing electronic, electromagnetic, computer controlled and radio controlled communications equipment. Must have a valid Federal Communications Commission (FCC) general radiotelephone operator license, and a valid driver's license; must become a resident of Youngstown within 120 days following appointment to the position. Examination applications will be accepted from December 20, 1999 to January 20, 2000.

For further details, call Youngstown Civil Service Commission: (330)742-8799 Fax: 330-742-8839

JACKSON ELECTRIC MEMBERSHIP CORPORATION, a rapidly growing electric utility serving more than 145,000 customers in Northeast Georgia, is seeking qualified applicants for the following position in its corporate office in Jefferson, GA.

ELECTRONICS SUPERVISOR

The successful candidate will have a degree in Electrical Engineering or Electrical Engineering Technology. Experience requirements include a minimum of 2 to 3 years of experience in one or more of the following areas - supervisory control systems (SCADA), conventional and trunking radio systems, analog and digital microwave, digital phone switches and electrical distribution systems. Specific experience in operating and maintaining an 800 or 900 MHz MAS radio is also desirable. Supervisory experience of personnel with technical backgrounds is required.

Jackson EMC offers a competitive salary, outstanding employee benefits and a stable, long-term work environment. Please visit our web site at www.jacksonemc.com for more information.

Qualified candidates mail their resumes, along with salary history and expectations, to:

Bill Burns, Director of Human Resources
Jackson Electric Membership Corporation
P.O. Box 38, Jefferson, GA 30549
Or fax to: (706)367-6141
Or e-mail to: bburns@jacksonemc.com

SALARY HISTORY AND EXPECTATIONS REQUIRED FOR CONSIDERATION!

Jackson EMC is an EEO/AA/V/H employer

Big Benefits? Absolutely.

Absolutely. FedEx.

At FedEx, the world's largest express transportation company, we reward our permanent employees with outstanding benefits like medical/dental/vision insurance, tuition refund and "jumpseat" privileges. If you have the spirit and drive it takes to succeed, you'll find big rewards at FedEx. Position is available in Long Island, NY.

Service Technical Representative

Successful candidates will have:

- An Associate's degree in Engineering, Electronics, Computer Science or equivalent
- 2+ years of experience in field installation and maintenance of radio and computer equipment including radio repeaters, antennas, modems, data line computers, LAN and CRT's
- FCC general radio-telecommunications license or NABER/PCIA certification
- Familiarity with low and high band, Motorola mobiles and repeaters and test equipment
- Knowledge of MS-DOS, and UNIX, PC's and Windows, Windows NT preferred
- Strong interpersonal and communication skills

Candidates must be at least 21 years of age and must not be colorblind. Must be able to operate FedEx vehicles in compliance with established policies and practices. The ability to lift 75 lbs. and maneuver packages any weight above 75 lbs. with appropriate equipment and/or assistance from another person is necessary. Health and safety monitor required as well as clean MVR.

Bring your unique talents to FedEx. It's absolutely, positively, the best decision you could make. If qualified, please send your resume, salary requirements and copies of either FCC or NABER/PCIA certification (must be included for consideration) to:

FedEx
Attn: E. Fried
570 East 108th Street
Brooklyn, NY 11236
Fax: (718)240-2452

FedEx
Federal Express
Be absolutely sure.™
www.fedex.com/us/careers
Equal Opportunity Employer, M/F/D/V

employment



TELECOMMUNICATIONS MANAGER

Placer County is seeking a highly motivated professional, telecommunications manager to plan, organize, direct and manage the activities of the Communications Division within the Administrative Services Department including the installation and maintenance of the County's two-way radio systems, telephone systems, 911 emergency system and administration of the County's cable television franchises; to coordinate telecommunications activities with other divisions and departments. Minimum qualifications/training include five years of increasingly responsible experience involving a broad range of duties, including two years of supervisory responsibilities; B.A. with major course in telecommunications, data processing business administration, public administration. Experience MAY be substituted as determined by the Personnel Department. Placer County offers an excellent benefit package and management incentives.

SALARY: \$4,459 - \$5,420 Monthly
FINAL FILING DATE: 1/21/2000

CONTACT:

Placer County Personnel Department
175 Fulweiler Avenue Auburn, CA 95603
Jobline:(530) 889-4070 Fax:(530) 889-4078
EEOE/AA EMPLOYER

RELOCATE TO THE SOUTHEAST

Immediate openings for bench and field technicians in southeast Georgia and northeast Florida.

Fourty year old MSS has openings in several of its eight locations. Salary plus benefits commensurate upon position and experience.

Send resume to:

Mike Hasty
Hasty's Communications East
112 Key Drive
Brunswick, GA 31520

Or Fax to: 912-264-3764

Two-Way Radio Technician

Successful individuals will possess experience in Smart-Net and LTR trunking formats. Must be able to trouble shoot and repair portables and mobiles. Growing Texas Gulf Coast service and sales facility. Top pay and benefits package.

Contact: Garry 409-948-9264

WIRELESS COMMUNICATIONS TECHNICIAN

Field technician—Must be experienced in systems: base stations consoles, microwave and data. PCIA or FCC certification preferred. Resume to:

Metropolitan Communications, Inc.
309 Commerce Drive, Exton, PA 19341
E-Mail: mcs@chesco.com
Fax (610) 524-9970

WIRELESS STAFFING SPECIALISTS

ALL LEVELS OF POSITIONS FILLED GLOBALLY

• Technicians • Engineers • Managers • Sales
Send resume to address below

Check web page for immediate openings
WWW.PERSONNEL1.COM



PERSONNEL RESOURCES, INC.

P.O. Box 14570, Cincinnati, OH 45250
E-Mail: Careercom@aol.com

☎ 606-491-5410 FAX 606-491-4340

TWO WAY RADIO TECHNICIANS

Growing Motorola MSS/SMR/Dealer is looking for two-way technicians with 2 or more years of experience (Motorola preferred.) Full benefits, good wages (\$12 to \$18 per hour) and excellent working conditions.

BAYCOM, INC.

2040 Radisson St., Green Bay, WI 54302-2085
Phone: 920-468-5426 • Fax: 920-468-8615
www.baycominc.com

Communications Technician

A Western Wisconsin Authorized Motorola Dealer/MSS of 42 years is seeking an experienced communications technician. An associate degree or land mobile radio/ military experience is needed. FCC license certification is preferred.

Please send resume to:
Rassbach Communications
Attn: Jennifer
2912 London Road
Eau Claire, WI 54701

Rassbach
Communications

WYOMING ROCKIES

Two way tech wanted to work in a Motorola shop in a small town near Yellowstone Park. Field, bench and mountain top work. Systems design ability desired but not essential.

FAX resume and salary req to:
307-587-9018

Electronic Technician

Large Metropolitan dealer is looking for an experienced Electronic Technician. Previous experience working on two-way radio communications systems, including installation and maintenance is required. Salary commensurate with qualifications and experience. Benefits. Send resume to:
Mobile Radio Engineering, Inc.
745 Boone Ave. N.
Golden Valley, MN 55427
e-mail: ddavey@visi.com

**Want to make your
employment ad stand out?**

Use your COLOR logo!

INTERTEC
PUBLISHING
A PRIMEDIA COMPANY

equipment for sale

CALL US FIRST at AIR COMM WHY PAY MORE!

Used/Reconditioned Motorola, E/GE, EFJ, Kenwood,
Uniden 2-way radios **and accessories**
—ALL FREQUENCY BANDS—

PLUS

"PL" and paging reeds/filters, TCXOS
Call us last to sell any of the above.

WE PAY CASH



AIR COMM

4614 E. McDowell Rd. Ph.: 602-275-4505
Phoenix, AZ 85008 Fax: 602-275-4555

BUY & SELL: LTR-800MHz & 900MHz EF Johnson • Kenwood • Uniden MOTOROLA

UHF • VHF • 800MHz • 900MHz
• Mobiles • Portables • Repeaters • Amplifiers • Paging Transmitters

1-800-786-2199

203 N. Chestnut Street • McKinney, TX 75069

Fax: 972-562-7957

Mike Malone

www.usedtwoway.com

STERLING
ASSOCIATES, INC.
Nationwide Purchasing and Sales of Used
Two-Way Radio Equipment



**BUY • SELL • TRADE
CLEAN WORKING EQUIPMENT**

NEW ARRIVALS

50-Spectratrac Receivers

Low/Mid/VHF/UHF/800/900 MHz
Voter & Digital Paging cards...CALL

400 4 new 2/8" HeliAx Antenna's
LDFRN-50-A

all or Part.....From \$2.50 ea.

➤ Motorola, GE/Ericsson used equip.
Many types more than can possibly list.
Including Base Stations • Repeaters •
Paging TX's • Mobiles • Voters • Re-
ceivers • Parts • Accessories • Remote
control equip. • 911 Consoles & DVP
equip. Including, but not limited to:
Spectra • Syntor X • Syntor X 9000 •
Maxtrax • Mitrek • Micor • MSF-5000,
MSR-2000.

➤ Centracom, I, II, II+ & Ranger •
Delta • Mastr II • EXII • MLS &
Phoenix.

*Units available on most frequency
bands. Specify when ordering. Sold
with or without accessories. Tested,
Untested, or as/is, priced appropri-
ately. Over 2000 Radios in stock,
Inventory changes constantly!*

BARNETT ELECTRONICS INC.

330 HWY 236 W., Loneoke, AR 72086

Orders & Bids: 800-423-3858 FAX: 501-676-2475

➤ For Expanded List look at our Website:
www.barnettelec.com

Call for info, or email bobb@barnettelec.com

Info: 501-676-5506

VISA & MC Accepted
NO COD's

Circle (104) on Fast Fact Card

Maximize your
company's
exposure in the
marketplace by
taking advantage
of **REPRINTS!**



Call Jenny Eisele
for a quote

Phone (913)967-1966
Fax (913)967-1898

A Passion For Excellence.

Call Today For Your FREE Catalog!

www.antenex.com

The image shows the cover of the Antenex catalog. It features a large, stylized city skyline (resembling Chicago) in the background. Overlaid on the skyline are various antenna products, including whip antennas, patch antennas, and other specialized designs. The Antenex logo is prominently displayed in the center. Text on the cover includes 'New Products!', 'Technical Data', and 'Antenex Inc.'.

Antenex is an established leader in the design and manufacture of innovative antenna products. Our latest Antenex Catalog is the perfect reference and buying guide for dealers. It features new products, as well as color photos, graphs, patterns, detailed descriptions and specifications of our full line of antenna products.

United States:

Phone: (800) 323-3757

Fax: (800) 851-9009

International:

Phone: (630) 351-9007

Fax: (630) 351-9009

Antenex Inc., 2000-205 Bloomingdale Road • Glendale Heights, Illinois 60139

Circle (105) on Fast Fact Card



Your Full Service,
VALUE-ADDED Distributor of
Communications Products.

Check out our Web specials!
www.radiocomm.com

- Wholesale prices to Dealers Only.
- Self-servicing users welcome.
- We carry a wide selection of both radios and accessories for your convenience.
- We have a Flat Rate Repair service.
- We sell and install MX-COM boards.

800-726-9015 • 612-808-0069

fax: 612-808-0087

email: sales@radiocomm.com

Circle (106) on Fast Fact Card

**DOES YOUR ADVERTISING
WALK AND TALK ?**

IF
NOT GIVE
THE LABEL EXPERTS
A CALL !!

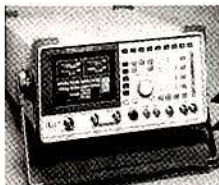
**Anchor
Graphics
Marketing, Inc.**
"The Label Experts"

972-242-0439 FAX 972-242-0959
1-800-875-7859



**FOR SALE H-P-8920-A
RADIO SERVICE MONITORS
QUANTITY (17) FOR SALE
WITH OPTIONS**

- (5) H-P-8920-A OPTIONS 2/3/4/5/13/14/50 ... \$8900
- (6) H-P-8920-A OPTIONS 2/3/4/5 \$8500
- (6) H-P-8920-A OPTIONS 1/2/3/4/5/10 \$8900



**ASKING
\$8,500**

- 500KHZ to 1GHZ Frequency Range
- Spectrum Analyzer w/Tracking Generator
- Duplex Generator/Digital/Analog Signaling
- LTR/EDACKS/MPT-1327 Trunking Test
- High Stability OCXO
- 8 Month Warranty & 10-day Right of Refusal
- Tested and Calibrated

**USED TEST EQUIPMENT WANTED,
FAX YOUR LIST TO +1 925-229-2035**

RF IMAGING & COMMUNICATIONS

+1 925-229-2034 • FAX: +1 925-229-2035

<http://www.best.com/~rfimage>
E-MAIL: rfimage@best.com



Circle (102) on Fast Fact Card

Don't miss our
updated web site!
Our pricing will
shock you!

Radius®

*See our NEW Motorola Dealer Referral Program

*Introducing the Motorola TS11 "Motorola Radios for Resellers"

*Need repairs? Call us for pricing. Our prices include all parts!

Visit our web site NOW or you'll not know what you're missing!

**From your RADIUS LEADER,
PROCOMM**

INFORMATION: 805-497-2397

805-494-5078

8:00 - 6:00 pm Pacific Time

Ordering: 800-497-2394

24-Hour Fax Line: 805-494-3115

805-497-3430

VISIT OUR WEB SITE: <http://www.procommusa.com>

e-mail: procommusa@aol.com

Where quality is #1, but where we want to be dead last when you call for pricing!

Circle (101) on Fast Fact Card

(540) 891-0569

We accept VISA and MasterCard

Fax: (540) 891-0538

**MECHEM
ELECTRONICS**

Massaponax Business Park
3605 Loren Whitney Drive
Fredericksburg, VA 22408
Mailing Address:
P.O. Box 7846
Fredericksburg, VA 22404

- ▶ Two-Way Radio Communications
- ▶ New and Reconditioned Radios
- ▶ Custom-Designed Radio Systems
- ▶ Repair and Programming
- ▶ Consulting

Hi-power/Lo-band PL Mitreks 29.7-38.9MHz
Saber I, UHF, DES hi-power (rack & indiv. chrgs, etc.)
Mid-band bases secure

Console interface units
Secure modems
Secure spectratrac receivers
Digitac comparators
Centracom II CEB cards, cont. panels & complete
GCC80 complete (MDC-1200 & MDC-600)
MSF 5000 VHF Secure repeaters
400W 150.8-162 & 162-174 rpters. - paging & secure
250W 450-470 repeaters. - clear & secure

URL Address: <http://www.mechemelectronics.com>

E-Mail: mechem@fls.infi.net

Circle (103) on Fast Fact Card

BUYING ERICSSON-GE EQUIPMENT

FLAT RATE REPAIR \$990 & 5-950	60
ASTRON R512A Black P.S. NEW	50
MPD 800 mhz rf decks, NEW	100
RCN 1000 REMOTES	135
IDA Control shelf, new from	200
VHF MASTR II Station from	1200
UHF MASTR II Station from	2200
800 Mhz MASTR II Station from	1800
Delta/Rangr Station from	450
S990 128 ch w/warranty	125
S600 4 ch control head	50
S600 Delta/Rangr Accessories	150
S600 control head	50
S550 control head non scan	65
S500 control head	65
PhoenixSX 16ch VHF w/acc.	150
PhoenixSX UHF w/acc.	165
MLSH040 VHF MLS w/acc.	250
MLS 35-42 & 42-50 w/acc.	250
MVS 150-174 w/acc.	250
MVS 440-470 with remote mtg kit, 2-ch, brand new	300
KPC 300 Ericsson VHF Port	225
MPA/MPD Std. rate chargers	42
MPI 8 unit multi-charger	40
Rangr 35-50 less acc. 60W	225
Rangr 30-42 less acc. 100W	325
DeltaS 450-470 less acc. 100W	225
DeltaSX 150-174 less acc. 100W	250
DeltaS 42-50 less acc. 110W	135
DeltaS 42-50 less acc. 60W	100
MASTR II 150-174 110W less acc.	125
MASTR II 29-26 110W less accessories	125

NEW LONDON TECHNOLOGY
752 Alum Springs Road • Forest, VA 2455
Tel: 804-525-0068 • Fax: 804-525-0078
www.newlondontech.com

**TRINITY RADIO
USED RADIOS at Low Prices!**

- MICOR
- MITREK
- PORTABLES
- MOCOM 70
- MAXAR
- RPTRS
- GE
- RCA
- ACCESSORIES
- TONE ELEMENTS
- CRYSTAL ELEM.
- BASE STATIONS

(940) 433-5452 • trinity-radio.com

Will pay **TOP DOLLAR**
for Motorola 800MHz Trunked
Mobiles & Portables.

Metro Communications LLC
(423) 546-0311 - Jim Hayes

Use the Reader Service Card to get more
information on an advertised product!

**WE
BUY
AND SELL
USED
MOTOROLA,
GE AND
ERICSSON
FM
TWO-WAY
RADIOS**

**SCHAEFER
RADIO CO.**
130 West
Fayette St.,
P.O. Box 395
Denver, IA
50622

PHONE
(319)
984-6115

FAX
(319)
984-6220

11 ea	PURC 5000 Bases, 900 MHz, C85JLB1101A
8 ea	MICOR PURC Bases, 900 MHz, C75JZB1101A
1 ea	SMARTNET Trunking Controller, T5076A
3 ea	MICOR Rptrs, 800 MHz, C55RCB5103AT
1 ea	TXRX 5 CHANNEL COMBINER
5 ea	GTX, 800 MHz, M11UGDG6CB1AN
81 ea	SPECTRA, 460 MHz, D44KMA7JA5BK
1 ea	MICOR Comm. Rptr, 460 MHz, C64RCB3105AT
6 ea	MICOR Bases, 460 MHz, C64RCB1105AT
12 ea	SYNTRON X 9000, 460MHz, T74KEJ7J04AK
71 ea	SYNTRON X 9000, 460 MHz, T34KEJ7J04AK
77 ea	SYNTRON, 460 MHz, T44SA3A20D
20 ea	GM 300, 460 MHz, M44GMC20A2AA
4 ea	M100, 155 MHz, D33LRA73A5BK
9 ea	RADIUS, 460 MHz, H34GUAU120
41 ea	PAC RT, 460 MHz, H14T7Y3110A
2 ea	MT1000, 460 MHz, H44GCU100BN
13 ea	RADIUS P110, 460 MHz, P94QLG20A2AA
1 ea	MSR2000 Base, 155 MHz, C73KS5B3106B
99 ea	SYNTRON, 155MHz, T83SRA3000AK
7 ea	MITREK, 155 MHz, T83JA3000
40 ea	PAC RT, 155 MHz, H13T7Y3110A
7 ea	SM50, 155 MHz, M330GC20A2AA
6 ea	M120, 155 MHz, M030GC20A2AA
4 ea	M100, 155 MHz, D33LRA73A5BK
10 ea	P110, 155 MHz, P430LC20A2AA
10 ea	P110, 155 MHz, P230LC20A2AA
30 ea	MARATAC, 48 MHz, T81XTA77A5BK
99 ea	MITREK, 48 MHz, T81JA4000
10 ea	MICOR Bases, 37 MHz, C71RTB1406
39 ea	MARATAC, 37 MHz, T81XTA77A5BK
99 ea	MITREK, 35 MHz, T81JA4000K
2 ea	MT1000, 33 MHz, H14GCU160
100 ea	Motorola SYSTEMS 90 Sirens

WANTED: RADIUS Mobiles, Portables, & UHF SYNTRONS

General Electric/Ericsson

MASTR II 110w, continuous duty repeater	\$1695	MOT Mostar UHF mobile w/ accessories	\$165
MASTR II UHF 110w, cont. duty rpt w/duplexer	\$1995	MOT Syntor 110w VHF mobile, 4 freq scan w/acc	\$165
MASTR II base stations	From \$1295	MOT Syntor X 110w VHF mobile	\$250
MASTR II 110w continuous duty amplifiers	\$595ea	MOT Maratrac 100w UHF mobile w/accessories	\$450
MASTR II VHF auxiliary receivers	\$395ea	MOT Mitrek low band mobiles from 100w 40-50mc w/acc, PL	\$195ea
PHOENIX SX VHF mobile w/accessories	\$200	MOT Mitrek mobiles VHF 100w, w/acc, PL	\$195ea
MASTR II 30" cabinets	\$165ea	MOT Mitrek low band mobiles, 30-40mc, 60w, w/acc, PL	\$160ea
DELTA SX 110w low band mobiles, 42-50 mc w/acc	\$395ea	MOT Mitrek 60w VHF base station, PL, 4 freq	\$495
DELTA SX 110w VHF mobiles, w/accessories	\$395ea	MOT Mitrek VHF 50w base station, local/remote control	\$495
DELTA SX 110w VHF mobiles w/825 heads and acc.	\$595ea	MOT Mitrek 60w 30 to 40mc base station, local/remote ctrl	\$550
DELTA DC control base stations, VHF	\$750ea	Rare find MOTOROLA Micor 100w UHF mobile on 406mc, Model T74RXA3903AA	
DELTA wall mount base stations	\$750ea	MOT Micor mobiles, 100w, UHF, w/accessories	\$175ea
DELTA wall mount 42-50 base stations, tone control	\$750ea	MOT Micor 100w mobiles, 42 to 50mc, w/acc	\$160ea
NEW S825 mobile microphones	5 for \$250	MOT Micor mobiles, 42 to 50mc, w/accessories	\$175ea
S825 control heads with brackets	\$250ea	MOT Micor mobiles, 42 to 50mc, drawer units, 100w	\$95ea
S550 mobile microphones	5 for \$100	MOT Pak Rat repeaters VHF	\$135ea
S550 control heads, scan	\$150ea	MOT Pak Rat repeater UHF	\$260
S990 control heads	\$50ea	MOT Mocom 70 base station 30 to 36mc, 100w	\$495
DECIBEL Products Duplexers, VHF, Model DB4060G-WC-C	\$1000ea	MOT Mocom 70 100w mobiles, 30-36, w/acc	\$195ea
DECIBEL Duplexers, Model 4076, VHF	\$375ea	MOT Mocom 70 VHF base station, 60w, 4 freq	\$295
Series 2500 console	\$500	MOT T1380 remotes	\$110ea
Series 503 consoles	\$500ea	MOT T1600 remotes DC	\$95ea
MVS VHF 16 freq scan mobiles w/acc	\$375ea	MOT T1600 4 freq tone remotes	\$185ea
PCS 6 position rapid chargers	\$125ea	NEW Kenwood TK-200 VHF, 5w, 6freq portables	
VOTER power supplies	\$100ea	no batteries	5 for \$300
VOTER panel with cards	\$495	Kenwood TK360 UHF portables w/batteries	\$210ea
RANGR 110w mobiles, 35 to 50mc w/accessories	\$395ea	Kenwood TK830 75w, UHF 32 freq scan mobile	\$385
RANGR 110w mobiles, 29 to 35mc w/accessories	\$395ea	Kenwood TH8050 UHF 16 freq scan mobile	\$235
IFR Model 1500 Service Monitor	\$5800	Kenwood TK801S UHF mobile w/ accessories	\$145
MPD/MPA 6 position 18 hour chargers	\$85ea	Midland UHF mobile, Mod 70-526BXL	\$140
MOT MSR 2000 UHF 450-470 MHz Model C74GSB-6146	\$1450	NEW Uniden programmer, Model AMX500C, w/ portable adaptor and manual	\$895
MOT Flexar 40w UHF repeater w/duplexer	\$495		
MOT Maxar, Maxar 80 or Moxie mobiles, UHF or VHF	\$85ea		

Wanted to Buy: GE, Ericsson or Motorola Equipment
NH Communications Co.

P.O. Box 5342

Manchester, NH 03108-5342

Tel: 603-668-3004

Circle (107) on Fast Fact Card

MOTOROLA RADIOS

RADIUS - RADIUS - RADIUS

NOBODY BEATS OUR PRICES-NOBODY BEATS OUR INVENTORY!

SP50 - P110 - GP300 - P1225 - SM50 - M130 - M1225 - GM300

MANY USED/DEMO TRUNKED & CONVENTIONAL RADIOS IN STOCK

HT1000-MARATRACS-SPECTRA-STX-MTX8000-PP1000X-MAXTRAC-MTX800

SALES: 800-545-7748 • FAX: 703-830-8710

VISIT US AT

http://www.radioexpressinc.com



Circle (108) on Fast Fact Card

Buy & Sell

Motorola, Uniden, E.F. Johnson, Kenwood
Two-Way Radios and Systems



DELTA COMMUNICATIONS

1-800-880-2250

FAX: 972-278-5085

Garland, TX

http://www.delta-twoway.com

CRYSTAL COMMUNICATIONS

QTY	FREQUENCY	DESCRIPTION
4	900	Geotack mobiles
6	900	Uniden 935TS mobiles
3	900	Uniden SP5920TS portables
5	900	Uniden LTR repeaters
100	900	Johnson 8570 portables
1	800	Maxtrac B1 mobiles, 2sys, 35watts
22	800	Maxtrac B5 mobiles, 2sys, 35watts
4	800	Maxtrac B6 mobiles, 10sys, 35watts
10	800	Maxtrac B7 mobiles, 10sys, 35watts
10	800	Maxar 80 Conventional mobile
44	800	GE TMX8615 mobile
6	800	GE TMX8625 mobile
100	800	GE Corona mobile
15	800	GE 100 watt repeaters
1	800	GE TPX port & veh chgr
80	800	Johnson 8700 mobiles
1	800	Bendix King portable
1	800	Motorola Duplex PP mobile
1	800	STX Converticom
1	800	PAC/RT with amp & speaker
40	490	Motorola Maxar & Maxar 80 mobiles
1	490	Motorola HT220 portable w/chgr
3	460	Motorola MT500 portable w/chgr
1	460	Motorola HT210 portable w/chgr
1	460	Motorola M100 mobile
2	460	Standard HX340U portable w/chgr
60	460	Uniden SMU300K, 36 frequency
2	460	Fujitsu FTP40-592H portable
5	460	Motorola Flexar Base
29	220	SEA mobiles
3	220	SEA portables
2	220	SEA 100 watt repeaters
25	150	Mitrek 100 watt mobiles
1	150	Motorola SM120 mobile
5	47m	RCA 100 watt bases
100	Motorola	Locking brackets
25	all	Mocom bases
100	Teletac	GPS units
1	Selectone	ST40 Hyperdyne base controller
25	Selectone	ST25B level 3 scramblers

Wanted or Trade Kenwood LTR Eq.
CALL DAVE at 510-895-9500

Circle (109) on Fast Fact Card

GP-68 GP88 GP-300

SPECIAL PRICES and in STOCK!

Keypad programmable GP-68

UHF 430-470 MHz

VHF 136-174 MHz

Features:

- PL/DPL built-in
- 9 DTMF memories
- Auto or Programmable Repeater Offset
- 1 or 5W Power level
- All GP-68 radios include:
- 3 hour rapid charger
- 1200mAh battery

E-mail: info@nsiradio.com

http://www.nsiradio.com



GP-68



NSI Communications

Tel: (206) 870-0888

Fax: (206) 878-4212

GP-68, GP-300, GP-88 trademarks of Motorola Inc.

We buy used Motorola radios

ACCES

514-735-2424

WANTED: Buyers who act on a good deal
Working Equipment for Sale:

HP/8657A	\$1,250	HP/8901A	\$650
HP/8903B	\$1,250	HP/8657D	\$1,850
HP/8901B	\$1,250	HP/8590X	\$4,500
HP/8903A	\$650		5,800

TRU CAL INT'L INC. // 130 9002, AZLA Lab
Ph# (630)238-8100 or (800)681-5540
Fx# (630)238-8101 truecal@aol.com

Advertise on the web to increase your visibility in the industry!

NEW LISTING OF PRE-OWNED RADIOS! JUST UPDATED!

VHF	Qty.	P110 4 Channel	Qty.
SP50 10 Channel	20	P200 6 Channel	22
P110 2 Channel	3	GP300 16 Channel	134
P110 6 Channel	7	GP350 16 Channel	109
HT600 6 Channel	2	MT2000 160 Channel	1
MT1000 8 Channel	30		
GP300 8 Channel	4	MISC	
GP300 16 Channel	6	Visar 800 16 Channel	1
		Visar 800T 16 Channel	1
UHF		GT800 16 Channel	2
SP50 2 Channel	3	MTX8000 16 Channel	1
SP50 6 Channel	7	MTX9000 16 Channel	2
SP50 10 Channel	3		
P110 2 Channel	1		

All radios include a 30-day warranty.

Open 7 Days 8am-8pm
Call to place your order or to request a FREE catalog!
1.800.272.7111
www.racingelectronics.com



mrtmag.com

**PROGRAMMING CABLES
FOR MOTOROLA PRODUCTS**

HT1000, MT2000—\$70
GP300, P110—\$50 • VISAR—\$110
HT600—\$48 • MOBILES—\$25 • SABER—\$55
HT50—\$50 • STX—\$35 • SPECTRA—\$35
PROGRAMMING INTERFACE—\$95

ROADRUNNER COMMUNICATIONS
PO Box 654 • South River, NJ 08882
Phone: 732-254-3232
Fax: 732-698-0555

All CCII
Labels

WHITE, ORANGE, GREEN AND RED
BUTTONS AVAILABLE

\$12.50 ea

CCII PROGRAMING AVAILABLE

ORDERS SHIPPED IN 14 DAYS

NORTHEASTERN
Communications, Inc.

Waterbury, CT (203) 575-9008

Universal Rapid Charger + Conditioner & Battery Packs

► MH-C888 Universal Drop-in Rapid Charger + Conditioner

- Support NiCD & NiMH 4.8 - 12V
- Universal Drop-in design for hundreds of radios.
- PowerShare features allow hassle-free charger banking, up to 12 units.
- 1 & 3 cycle conditioning mode.
- FLEX pulse charge.
- Built-in switching power supply.



► Battery Packs

Hundreds of NiMH and NiCD rechargeable battery packs available for Motorola, Kenwood, Icom, Vertex, Standard two-way radios.



MAHA

"Your Supplier, Your Partner,
Your Friend!"

Tel: 1-800-376-9992 or 714-985-9132 Fax: 714-985-9221
2841-B Saturn St. Brea, CA 92821

<http://www.maha-comm.com/>

Circle (114) on Fast Fact Card

SKORY COMM LANSING, MI 48911

USED EQUIPMENT ALL ITEMS IN GOOD WORKING CONDITION

3	GE MARC V 800MHZ REPEATER COMB #	
	MASTR II SIVZY100 WITH IDA CONTROLLER	
	IN 2 CABINETS	\$5,500
1	DB8508 DB 8 CHANNEL MULTI COUPLER	\$600
1	DB4458 DB 5 CHANNEL COMBINER	\$1,500
1	DB4190 & 92 SHAPE FILTER & ANTENNA COUPLER	\$400
1	MLSL161 GE LOW VHF MOBILE 40 WATT	\$45
2	CM4020 MAXON 20 WATT UHF MOB	\$75
1	GE UHF REPEATER 100 WATT MULTI TONE	\$45
	PANEL (STILL ON THE AIR BEING USED)	\$600
1	BCR10A BOGNER 800MHZ ANTENNA 10DB GAIN	300

NEW EQUIPMENT

2	ASPG680 ANT SPEC BASE ANT (171-174)	
	3DB FIBER GLASS	\$70
3	8615 -LTR JOHNSON MOB 800MHZ	\$175
1	TL800 -GE G-MARC MOBILE 800MHZ	\$50

800/322-5124 ASK FOR SMITTY

BUY•SELL•TRADE

GE Delta SX Mobile, VHF & UHF, 100W .. \$250.00
Accessories with 950 head \$100

GE Ranger Mobile, VHF, 40W \$200

MOT MCX 100, T44 Rearmount Mobile, UHF,
450-470, NO PL or Prom, AS IS PRICE \$30

MOT & GE Indoor 30" & 40" Cabinets \$225

**WOLFE
COMMUNICATIONS**

1113 Central Avenue
Billings, MT 59102
Phone: 406-252-9220
Fax: 406-252-9617

<http://members.aol.com/cwwolfe.com>

USED EQUIPMENT FOR SALE

25	Uniden SMU-4525KT w/accys and	
	AMX-250 Spkr	\$225.00
20	Maxon SM-2450 w/ accys and	
	AA-1470 Spkr	\$225.00
10	Maxon SL-70WV2 VHF H/H w/HD Battery	
	and desk charger	\$225.00
1	Yaesu/Vertex FTH-2070 Dual Band H/H w/	
	rapid charger. NEW CONDITION	\$750.00
1	5 Channel EF Johnson 220 MHz Trunking	
	System complete w/TX Combiner and RX	
	Multicoupler	\$10,000.00
1	Quintron VHF Paging Tx w/72 MHz control	\$2,500.00
	D&G Communications, Inc.	409-948-9264

CMC ENTERPRISES 2-WAY, MICROWAVE & TELECOM EQPT.

Quantity	Equipment List	Price
02	CENTRACOM II CES w/30 BMS	\$1200.00ea
15	GE MASTR II Repeaters 100W Hi & UHF w/ Duplexer	\$1200.00ea
10	MOTOROLA MCOR 800 Mhz Conv. PPTT 75W PA w/Dup	\$1200.00ea
10	MOTOROLA DMR200 900Mhz Data Radio (U/mult)	\$225.00ea
15	FARION FAS3000E Hot Sticky 60Hz Radios (Per terminal)	\$3500.00ea
06	Rockwell-Collins MRP-2 HOT Sticky 60Hz (Per terminal)	\$3000.00ea
50	MOTOROLA Starplex Channel Modems MLN6237	\$150.00ea
06	MOTOROLA MSF 5000 UHF Pairs 100W EPROM Type	\$2300.00ea
05	MOTOROLA MR-603 Non-sticky loop radios 60Hz 300 Ch	\$1000.00ea
50	MOTOROLA Starplex Term Cards MLN6286	\$80.00ea
03	MOTOROLA Comparators, Signal to Noise type	\$400.00ea
06	CENTRACOM II Consoles, less CEB	\$300.00ea
10	MOTOROLA MR-603 HOT Stand-by 60Hz 300 Channel	\$1500.00ea
08	FARION LR 1-2 HOT Stand-by 2 1 to 2.3 Ghz 48 Channel	\$1500.00ea
12	FARION LR 1-4 60Hz Radios w/ HOT Sticky Very Good Cond'n	\$2000.00ea
01	Scherdick-Atlanta 4654a BERTIS Transmitter (DS1/C2)	\$1000.00ea
01	Scherdick-Atlanta 4654a BERTIS Receiver (DS1/C2)	\$1000.00ea
95	COLLINS MX 108 Channel Modems 30 AGRE-MX	\$80.00ea
70	COLLINS MX 108 Channel Modems 30AG10-MX	\$80.00ea
200	MOTOROLA M-Trak 30-39 60W w/accessories w/PL	\$125.00ea
20	MOTOROLA MTX 810/classic multi-system multi-subtle	\$150.00ea
80	GRANICH DTL 7300 Channel Modems with E&M Signaling	\$125.00ea
New Listing Call Charles at 336-769-2885		
For more equipment, visit our website at www.cmcnet.com		

Intertec Books

www.internettelephony.com

Your Internet Shopping Resource



**INTERTEC
PUBLISHING**
A PRIMEDIA COMPANY

Audio Accessories for 2-Way Radios!

Klein
electronics
(800) 959-2899

Fax: (760) 631-1163

E-mail: info@kleinelectronics.com

Web: www.kleinelectronics.com

Call Now!

K700-
"Public Safety"



Tactical Headset
Bike Patrols
SWAT Teams

K500-
"Top Seller"



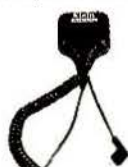
Dual Muff Headset
for Safety Helmets

K400-
"Best in Class"



Dual Muff
Headset w/Noise
Cancelling Mic

K9725-
"Easy to Use"



Heavy Duty Remote
Speaker Mic

K111-
"Affordable"



2 Pc.
Lapel Kit

Circle (110) on Fast Fact Card

TEST EQUIPMENT - BUY & SELL!!

SERVICE MONITORS All include NIST Traceable Calibration

HP8920A/102/3/4/5/13	\$7900	HP8920B 001/102/4/13/\$13.500	
HP8921A/600 (CDMA)	\$10.500	HP8921A	\$8900
HP8920A/113/4/5/13	\$6500	HP83215A	\$990
IFR COM120B (2/12/20)	\$9900	IFR 1200SS/12	\$7500
IFR 1600S	\$7900	IFR 1200S/12	\$6500
Motorola R2600CCBS	\$16.500	Motorola R2600C	\$8500
Motorola R2600B	\$6900	Motorola R2600BNT	\$6400
Motorola R2012D-0900 (Trunk 1&1)			\$7800
Motorola R2014D-0900 (Trunk 1&1-Secured)			\$7900
Motorola R2024D (Secured)	\$6500	Motorola R2400A	\$4500
Wavelek CAT600 (cellular activation tester)			\$950
Marconi 2957D	\$4900	Motorola R2200B	\$3400
Marconi 2955B	\$4500	Marconi 2955B	\$4500
Wilton Sitemasters	call	Motorola R1192A Rubidium	\$5200

Eagle Return Loss Bridges Call
Synth. 1000 Mhz Signal Generators:
Rocall 9087-1300Mhz Signal Generators, low phase noise, high stability,
AM/FM/Pulse/Phase Modulation. NEW units with warranty!-\$3500;
HP8657A-\$2900. Marconi 2022A-\$1800.; 2022C-\$2000

Amtronix Instruments, Inc.
Ph: 716-763-9104 • Fax: 716-763-0371
http://www.amtronix.com

Simulcast
SOLUTIONS

716.223.4927 TEL
716.223.3255 FAX

www.simulcastsolutions.com

Run digital through
analog microwave.

Circle (111) on Fast Fact Card

COMPLETE CHANNEL ELEMENTS
YOUR FREQUENCY
LIFETIME GUARANTEE
Most Elements \$20.00 With Trade

Crystals
We Buy Used Elements
NKX
1814 Hancock St.
Gretna, LA 70053
504-361-5525 (in LA) • 800-237-6519
FAX 504-361-5526

Lots of New Two Way Radios!

For immediate delivery

... at the very best prices!

KENWOOD YAESU VORTEX ICOM

Prices Starting at \$59!

Programming hardware kits \$89.00
Icom repeater maker kits \$79.00

Free Items in 20+ Radios Ordered!

Portable, Base & Mobile Antennas: Decibel, Larsen, Maxrad, Hustler, Antenex, Cushcraft, ASP and more

Coax Cable: Belden & Helix

Conventional and Switching power supplies: Astron & Samlex

R.F. Test Equipment: IFR, Bird, Optoelectronics, Ramsey

Connectors, audio accessories, batteries, solar modules, R.F. amplifiers, Lightning protectors, trunking panel, interconnectors.....

10' tower sections. Prices start at \$33.00

Duplexers Syscom, Decibel, Wacom, prices start at \$129.00

EPCOM

MIAMI, FL.
7262 NW 54 St.
(305) 889-1127 FAX 889-0652
MIAMI, FL., 33166 U.S.A.
E-mail: epcom@bellsouth.net

Ask for your free Catalog

EL PASO, TX
1630 PAISANO DR.
(915) 533-5119 FAX 542-4701
EL PASO, TX. 79901 U.S.A.
www.epcom.net epcom@whc.net

Circle (112) on Fast Fact Card

USED EQUIPMENT
BLOWOUT

\$AVE on Thousands of Used Items in Stock Now

Portables, Mobiles, Repeaters, Base Stations, Tone Remotes, Power Supplies, Batteries, Service Monitors, Pagers, Accessories and More...

TelePath

49111 Milmont Drive • Fremont, CA 94538-7347
1-800-292-1700
or (510) 656-5600 • Fax (510) 656-2114
Visit us on the Web at: www.telepathcorp.com

Circle (113) on Fast Fact Card

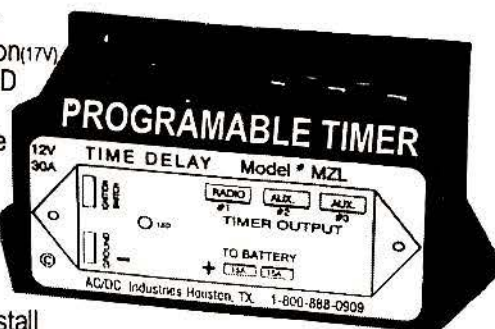
Delay Timer

Protects The Battery & Radio Equipment

"On when ignition is off"

1. Battery Guard - Low Voltage Shuts Down Load
2. Maintains Power to Accessories

- Low Voltage Detector
- High Voltage Protection (17V)
- Built-In Diagnostic LED
- 30 AMP 12 Volt DC
- Sealed From Moisture & Vibration
- Reliable & Accurate
- Allows Retrieval of Incoming Messages
- Intrinsically Safe
- Compact - Easy to Install
- Low Cost- from \$49.00



(800) 888-0909

AC/DC INDUSTRIES

P.O. BOX 710548, HOUSTON, TEXAS 77271
Tel: (281) 933-0909 • Fax: (281) 933-1001

Circle (115) on Fast Fact Card

SAVE BIG BUCKS ON
Used 2 Way Radio
MOTOROLA • GE • EF JOHNSON etc.
PORTABLES / Pagers / MOBILES / BASES / REPEATERS

Contact us when you are looking for economical used equipment. We are a reliable source for all major brands of used 2 way gear

(708) 681-0300
Buy • Sell • Trade

Visit our web site: WWW.MDMRADIO.COM
or E-Mail us at mdmradio@earthlink.net

MDM Radio Ltd.
1629 N. 31st Ave. Melrose Park, IL 60160
Tel. (708) 681-0300 Fax (708) 681-9800

• BOARDS • STRIPS • ACCESSORIES • ELEMENTS • REEDS •

PCI — PEKAAR COMMUNICATION INC.
Steve's back, formerly of Gregory Electronics Corp.

\$ Specials of the month \$

MOTOROLA Portable MT500 high band H33BBU3100	\$50
GE Model TMX6415 800MHz Trunking Mobile	\$85
GE MPS Portable high band synthesized	\$60
Johnson Mobiles 800 Mhz range model 2428600	\$40
MOTOROLA Syntor XX 30-50 range 100W w/accessories	\$225
GE MLS mobiles high band, with mic & bracket	\$165
GE MPA Portable 16ch high band with antenna & battery	\$200
MasterPro 100w Highband Base, Complete As-is	\$75
GE PHOENIX Mobile NSH11W40TB—high band dual priority scan/grey case with accessories	\$200 ea.
GE PCS Portable 470-490 range w/battery & antenna	\$175
MOTOROLA Mitrek 39-50 range 100W w/accessories	\$150
GE Exec II 100W mobile 30-50 range w/accessories	\$75
MOTOROLA Micor 42-50 range 100W range w/accessories	\$100

Catalog Available...If you can't find it, try us! Call (973) 772-0704 or fax (973) 340-1902

• BUY • SELL • TRADE •

AVL / GPS EQUIPMENT

MOTOROLA Radius
Lowest Prices!

"NEW" **PRO 5150/7150/9150**
GP 88 & 68 VHF/UHF
Most popular models in stock!
Complete Radius Line!

KENWOOD
New and Used
(some restrictions may apply)

Special State & Local Gov. Discounts
1-800-264-9516
FAX 303-415-1557
COMMUNICATIONS WEST, LTD.
E-Mail: commwest@aol.com
DOMESTIC & EXPORT SALES

LOWEST PRICES!

3 - NEW
Radio Cables
19, 20 & 21

Radio Programming Cables

Model #s	The Motorola® Radio It Programs	Price
1	HT50 and the Radius P100 Models	\$59. ⁹⁵
2	HT600, MT800, MT1000, P200, P500, MTX800, MTX810, MTX820, MTX900. (connection on top of radio)	\$85. ⁹⁵
3	MARATAC, (MAXTRAC - 50, 100, 300, 820, 840, M860), M1225, (RADIUS - M100, M206, M208, M214, M216, M400, GM300), SM10, SM50.	\$59. ⁹⁵
4	STX, STX Gemini, STX 821 trunked portables.	\$79. ⁹⁵
5	SABER and System SABER.	\$99. ⁹⁵
6A	SPECTRA Low and Medium Power Units.	\$79. ⁹⁵
6B	SPECTRA 100 Watt and High Power Units.	\$149. ⁹⁵
7	SYNTOR 9000 and 9000E Radio Line.	\$99. ⁹⁵
8	Radius P 50 Plus.	\$49. ⁹⁵
9	R100 Repeater.	\$65. ⁹⁵
10	MCX1000.	\$79. ⁹⁵
11	Cloning Cable for the Motorola® HT600 / MT1000.	\$149. ⁹⁵
12A	GP300, GP350, and P110 Models.	\$75. ⁹⁵
13	MSF5000 Digital Unit with 3 Digit Display in Controller Tray.	\$135. ⁹⁵
14	HT1000, MT2000, MTX 838, MTX 8000, MTX 9000 (connection on side of radio) and JEDI Series.	\$119. ⁹⁵
15	Visar Unit.	\$129. ⁹⁵
16	Cloning Cable for the Motorola® JEDI Series.	\$99. ⁹⁵
17	ASTRO SABER and SABER SI.	\$99. ⁹⁵
18	SP50.	\$59. ⁹⁵
19	M1225.	\$119. ⁹⁵
20	P1225.	\$79. ⁹⁵
21	HT750, HT1250.	\$79. ⁹⁵

Your Order Shipped Same Day! Order by 1pm EST.

Polaris Industries
Tech Info: 404.872.0722
www.polarisradio.com

Compare These Important Points, Before You Buy!

- Same Day Shipping, When Ordered before 1pm EST.
- We Accept: American Express, Discover, MasterCard and Visa.
- Professional Users Guide with Detailed Photos Included with All Radio Products.
- Compare Polaris' Features and Quality, Don't Accept Imitations!

Compatible Motorola® Radio Programmers

PA-I Programming Adaptor...\$139.95
• Compatible with "RIB" unit.
• Rugged steel case.
• Power LED.

PA-II Programming Adaptor...\$159.95
• Contains rechargeable Ni-CAD Batteries.
• Perfect for field use and Portable, Laptop & Notebook Computers.
• Status LEDs: Power On and Charge.
• Power Switch.
• Power / Charger Included.
• Runs for 8 continuous hours, from a full charge.

PA-III Pocket Programmer...\$189.95
• Micro-Size Design for Convenient Portability and Field Use.
• Uses Surface Mount Technology.
• Rechargeable — Works hours on one charge.

NOTE: Hardware Only. Software from Motorola and other products are trademarks of Motorola, Inc.

American Express DISC VISA

Polaris Industries Inc.
470 Armour Dr. NE • Atlanta GA 30324
FAX 404.872.1038

1-800-752-3571

Circle (116) on Fast Fact Card

DEALERS WANTED

Now you can be a dealer in a new line of
MOTOROLA 2-WAY RADIOS

WETEC ELECTRONICS

AUTHORIZED MOTOROLA TS-11 DISTRIBUTOR

Call Now 1-888-GO-WETEC, ext. 11

Visit our website at: www.wetec.com

World's First Talking 32 Channel Radio

SUPER BUYS

- Motorola 450 MHz LTR, NEW
List \$580 ea., Dealer cost \$350 ea.
Your Cost \$300 ea.
—Limited Time Offer—
- GTX 800 MHz Mobile \$199
- MTX 8000's – B3's portable \$199 ea.

Circle (118) on Fast Fact Card

BUSINESS SALE OFFERING

Repeater Channels

**Northwest Alabama - Florence area
business closing - 8 UHF available now**

D&G Communications & Electronics
P.O. Box 3136 Florence, AL 35360
Phone: 256-740-2523



DANGER!

If you aren't advertising on the
MRT WEBSITE,
you're in dangerous waters!

Call Dawn at 1-800-347-9375
to place your ad today!

ICT

TWO WAY RADIOS

LOWEST PRICES OF THE UNIVERSE!!
Tons in Stock - Same day shipping guaranteed!!
SP50 - P110 - GP300 / 350 - P1225 - P200 + GP68
GP88 - SM50 / 120 - M120 - M1225 - GM300

7875 N.W. 29th St. - Miami, FL 33122
305.640.2424 - Fax: 305.640.0756

All models covered in this ad are trademarks of Motorola Inc.

Visit us at www.ictwireless.com

Circle (119) on Fast Fact Card

INFONET
2000 INC.

Your #1 Source for Pagers,
Cellulars, Computers & Parts

Tel: (954)227-9779
Fax: (954)227-9757
e-mail: infonet@gate.net
Florida ♦ USA
100% Satisfaction
Guaranteed

LABELS • LABELS • LABELS

Custom Made Labels for Pagers, Cell Phones & Two-Way Radios
Distinctive Foils & Holographic Materials
Tamper-Proof Warranty Labels
Screen-Printed Labels, Signs, Overlays
Motorola Certified Pager Repair Labels
Bar Code Thermal Transfer Printing Systems

ADVANCE LABEL & TAG

1-800-466-5345
Fax: 972-2518

972-542-5345
www.altag.com

Get more exposure from your classified ad -- advertise on the MRT website!
www.mrtmag.com

micropath® corporation
software and terrain data for communications engineering applications

Radio Propagation Software

- Predicted Area Coverage Maps
- Microwave Link Analysis & Profiles
- USGS GeoReferenced Topo Maps on CD-ROM

www.micropath.com

303.526-5454 Sales
303.233-4242 Support
303.233-4026 Fax
e-mail: sales@micropath.com

The Solution for Business Information

Computer Based Record Keeping
Inventories • Expenses • Billing • Sales

— Record keeping customized for your business —
— www and custom interfaces —

CALL FOR A FREE CONSULTATION

Phone: (913)707-4945 E-mail: jknupp@mid-west.net

Put your message in front of
26,085 qualified recipients
each month* in MRT's Classifieds!

** based on Dec. 1997 BPA.*

**** WIRELESS SOFTWARE ****

Save time designing, optimizing and managing wireless Radio communication sites:

- Intermodulation Interference Analysis
- Transmitter Noise Analysis
- Receiver Desense Analysis
- Signal Level Analysis
- Communications Site Design
- Site Management Database
- Equipment Maintenance and Inventory
- Desktop Mapping and Data Products

COMSITE™

CALL 800-845-0408 or 850-906-0748
http://www.polaris.net/~douglas

The worst mistakes are the ones you can't see.

*Global Trunking Management
& Billing Solutions for...*

SmartNet • SmartWorks • SmartZone
LTR • MPT 1327

For more information,
call (903) 561-6673 or
www.GenesisWorld.com

Genesis
where great ideas begin...

Circle (120) on Fast Fact Card

Fixed Quick, Not a Quick Fix

Your customers demand speed and precision and you should too. **CRI's Service Management System** is designed specifically to track all aspects critical to the successful management of your two-way repair facility. Fast. Easy. Flexible. Call CRI today.

205/987.1523
email:
info@crinc.com

cric computer resources inc.

MEASURE SIGNAL COVERAGE!

- Automate field measurements and drive-tests.
- Create signal contours from measured data.
- Compatible with HP, IFR, Z Technology and other instruments.
- Use your NMEA or TSIP GPS receiver.
- Automatically records signal

STI-9400 Software
\$4,995.00 Includes
Street Map Data for USA

FREE DEMONSTRATION CD

Toll Free: (877) 848-8500 Fax: (503) 848-8534

Email: sales@surveytech.com

Survey Technologies, Inc.

"Geographic Signal Coverage At Your Fingertips"

www.surveytech.com

Circle (121) on Fast Fact Card

Find Solutions

**To Your RF Coverage and Site Management Problems...
On your own PC!**

For either microwave links or area coverage, our **Terrain Analysis Package (TAP)™** software helps you find system design solutions **in-house**.

See details and download demo from our web site!

SOFTWRIGHT, LLC
1010 So. JOLIET ST, SUITE 204
AURORA, CO 80012-3150 USA
TEL: (303) 344-5486 • FAX: (303) 344-2811
www.softwright.com
e-mail: sales@softwright.com

Circle (122) on Fast Fact Card

prof. cons. services

Engineering For The Wireless World
Wireless Communications Systems and Facilities

Define Acquire Build Manage
Design Zone Test Operate

RCC Consultants, Inc.

100 Woodbridge Center Drive, Suite 201

Woodbridge, NJ 07095

800-247-4796

email - info@rcc.com

Offices Nationwide & International

Circle (100) on Fast Fact Card

Envision

THE FUTURE
OF YOUR BUSINESS

*Advertise
in MRT*



Cardinal Electronics, Inc.

SERVICE MONITOR Repair & Calibration

Exclusive Monitor repair since 1973
NIST TRACEABLE NEW LOWER RATES



Visit our Website: cardinalelec.com



1631 N. Evergreen Ave. Arlington Heights, IL 60004
Ph. (847) 797-7820 Fax (847) 870-0342

Cushman / IFR / Motorola / Wavetek

Get Your Test Equipment Needs
From Service Professionals.
We Buy & Sell Service Monitors.

Communication Service Monitor
Repair & Calibration Specialists



www.nselectronics.com

NS Electronics Service, Inc.

3610 Dekalb Technology Pkwy.
Suite 110/111
Atlanta, GA 30340
Phone: 770-451-3264
Fax: 770-458-8785

Loudoun Communications Inc.

Communications Systems

REPAIR DEPOT

QUALITY SERVICE ON MICROPROCESSOR-BASED
MOBILES, PORTABLES AND CONTROL HEADS.

SURFACE MOUNT REPAIR. MOST REPAIRS \$70 PLUS PARTS.
FREE ESTIMATES.

Warranty Service Available On:
Ericsson/G.E. • Kenwood

585 Factory Shoals Rd.
Austell, Ga. 30168

770-948-9566

Don't let
time catch
up with you!

Get your ad
in today!

800-347-9375

IT IS POSSIBLE!!!

...to receive quick, quality, service at affordable rates.

ADVANCED COMMUNICATIONS & ELECTRONICS INC.

Service of:

- Radios
- Transmitter Amplifiers
- Tower Top Amplifiers
- EDACS Equipment
- Custom Projects
- Equipment Modifications

78 Airpark Drive Phone/Fax (804) 237-8255
Lynchburg, VA 24502-3757 Toll Free: 1-800-488-7908
E-Mail: advcomm@worldnet.att.net

MOTOROLA \$49 Flat Rate Plus Parts

PORTABLE & MOBILE REPAIR

- Quick Turn Around • Free Return Shipping
- Factory Trained & FCC Licensed Techs



800-567-5636
www.laker.net/arcom

11110 W Oakland Park Blvd, Suite 275, Sunrise, FL 33351



Minitor II Pager
Repair Just \$32.50
Price includes all
Parts and Labor

5 Day turn time
90 Day Warranty

Dealer Price

800-822-2180

1300 N FL Mango Rd #26
West Palm Beach, FL 33409

Water/Physical Damage and
housing parts not included



businesses for sale

BUSINESS FOR SALE

Radio Communications Sales and
Service Shop. Located in Northern
California, represent leading
manufacturers. Includes 800 MHz
and UHF trunking systems. Grossing
over a million dollars annually.

For Information, call (916) 870-4026

tower space



CHECK THE FACTS THEN
CALL THE BEST!

CHICAGO TOWER LEASING CORP.

Environmentally controlled
equipment enclosures, back-up power,
RF engineered sites. Secure.

Premiere sites in Metro Chicago Area—choice of
Federal State, Govt. & all Class A Systems.

STAN STANN
105 MURPHY LAKE ROAD
PARK RIDGE, IL 60068

(847) 823-7713



MOTOROLA RADIO RENTALS

Ten years of great
service to you!

Call for a quote.
We'll make your next
project affordable.

Spider Moss

www.mosscom.com
800-822-MOSS



MOTOROLA RADIO RENTALS

- HT1000, GP300, P200
- Intrinsically Safe
- Full Line of Radio Accessories
- Mobiles & Repeaters
- 24-Hour Service
- Dealer Inquiries Invited

1-800-283-COMM

EVENT RENTAL COMM., INC.
e-mail: eventcomm@aol.com

GO
NATIONAL

MRT
Classifieds

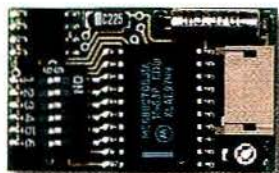
REILLY RADIO COMMUNICATIONS

Family run business established in 1972, large
customer base, major manufacturer
representative, repeater sites and equipment
negotiable.

(908) 637-4000 - Michael Reilly or
(973) 236-4274 - Kathleen Reilly

ad index

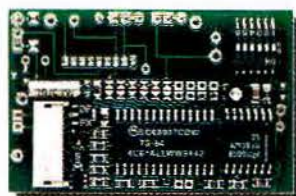
Company	Page Number	Fast Fact Number	Advertiser Hotline	Company	Page Number	Fast Fact Number	Advertiser Hotline
AEA, div. of Tempo Research.....	31	22	760-598-8900	Motorola Test Equipment.....	11	10	800-422-4210
AeroComm, Inc.	IBC	2	201-227-0066	Narda/L3 Communications	7	7	516-231-1700
American International Radio	26	19	847-818-9999	Natl. Assn. of Tower Erectors.....	41	35	605-882-5865
Antenex	47	105	800-323-375	N.C.G. Co.	32	23	800-962-2611
Astron Corp	5	6	949-458-7277	New Hampshire Communications ...	49	107	603-668-3004
Barnett Electronics Inc.	47	104	800-423-3858	New Mar	41	36	714-751-0488
Berkeley Varitronics	17	14	732-548-3737	Norcomm Corp.	42	34	800-874-8663
Canamex Communications Corp ...	34	40	800-387-4237	Otto Communications	14	12	847-428-7171
Ceotronics Inc.	23	38	972-416-9500	Paging & Wireless Service Center ...	38	31	800-822-2180
Champion Radio Products	38	32	206-890-4188	Polaris Industries	52	116	404-872-0722
David Clark Co., Inc.	29	21	508-751-5800	Polyphaser Corp.	19	15	800-325-7170
Communications Specialists	BC	3	800-854-0547	ProComm.....	48	101	805-497-2397
Control Signal Corp.	27	20	800-521-2203	Quantum Radionics	44	117	703-884-8548
CPI Communications Inc.	42	37	800-869-9128	Radio Express, Inc.	49	108	703-631-1365
Crystal Communications	49	109	510-895-9500	RadioMate	25	18	800-346-6442
Diversified Electronics	34	24	404-361-4840	RCC Consultants	54	100	732-404-2400
DLC	39	33	562-404-9998	RCW Distributing	47	106	612-808-0069
Duracomm Corp.	35	25	800-467-6741	RF Imaging & Communications.....	48	102	925-229-2034
EAGLE	22	39	520-204-2597	Simulcast Solutions	51	111	716-223-4927
Earmark, Inc.	22	41	203-777-2130	Softwright	54	122	303-344-5486
E.F. Johnson	1	4	800-328-3911	Southwest Windpower.....	37	30	520-779-9463
EPCOM	51	112	915-533-5119	Survey Technologies, Inc.	23	16	503-848-8500
The Genesis Group	54	120	903-561-6673	Survey Technologies, Inc.	54	121	503-848-8500
Globe Electric.....	52	115	281-933-0909	Telepath	51	113	510-656-5600
Henry Radio	36	27	800-877-7979	Telewave, Inc.	35	26	800-331-3396
I-Com Industry, Inc.	37	29	703-707-9094	Thunder Eagle	36	28	888-877-8022
International Cellular Telephone ...	53	119	305-640-2424	TX RX Systems Inc.	3	5	716-549-4700
IWCE 2000	15		800-288-8606	Vega/Telex Signaling Products	10	9	402-467-5321
Klein Electronics	51	110	760-631-2811	VERTEX/YAESU USA	IFC	1	562-404-2700
Larsen Electronics	13	11	800-ANTENNA	Vocom Products Co. LLC	40	42	847-593-1213
Maha Communications	50	114	714-985-9132	WETEC	53	118	901-286-6275
Mechem Electronics	48	103	540-891-0569	W & W Manufacturing	9	8	800-221-0732



SS-64 **\$28.95**
 Microminiature DIP Switch Programmable CTCSS Encoder.
 Includes 64 tones from 33.0 to 254.1 Hz.
 .66" x 1.08" x .21"



TS-64 **\$54.95**
 Sub-miniature Programmable CTCSS Encoder-Decoder.
 Includes 64 tones from 33.0 to 254.1 Hz.
 .78" x 1.70" x .25"



TS-64DS **\$57.95**
 DIP Switch Programmable CTCSS Encoder-Decoder.
 Includes 64 tones from 33.0 to 254.1 Hz.
 1.25" x 2.0" x .30"



ANI-1/\$39.95 **ANI-2**/\$299.95
 Automatic Number Identification System
 ANI-1 Encoder - 1.13" x .66" x .22"
 ANI-2 Station Decoder - 5.4" x 5.8" x 1.4"



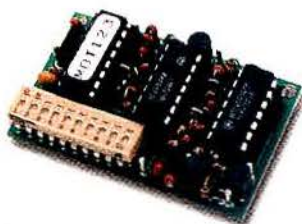
ID-8 **\$69.95**
 Automatic Morse Station Identifier. Meets all FCC
 ID Requirements. Fully field programmable
 with included keypad. 1.85" x 1.12" x .35"



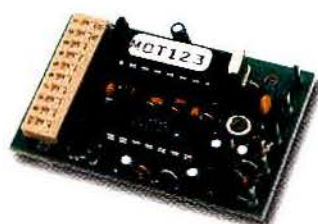
TP-3200 **\$279.95**
 Full Featured Shared Repeater Tone Panel with ALL 157
 CTCSS/DCS codes. In Desktop or Rack Mount versions.



PE-1000 **\$224.95**
 Desktop Paging Encoder. Two-Tone Sequential,
 other formats available. 7.5" x 7.8" x 2.7"



SD-1000 **\$59.95**
 Two-Tone Sequential Decoder. Programmable unit
 provides switched outputs from Two-Tone paging calls.
 1.25" x 2.0" x .4"



PE-2P **\$54.95**
 Two-Tone Sequential Encoder. Sub-assembly mounts
 inside radio or other enclosure. Multiple call capability.
 1.25" x 2.0" x .4"



DCS-23 **\$59.95**
 Digital Coded Squelch Encoder-Decoder. Programmable
 to all 106 DCS codes. 1.36" x 1.18" x .25"



TE-64D **\$129.90**
 Multi-Purpose CTCSS/Burst Tone Encoder w/LED Display.
 Great for the Benchtop. 5.25" x 3.3" x 1.7"



FILTERS
 Call us for the lowest cost, 12.5kHz channel spacing,
 exact replacement, crystal and ceramic IF filters for
 Part 90 Refarming.

- Same reliable and cost effective products you have known and trusted for 30 years!
- Full FIVE YEAR WARRANTY on all products
- Same day shipping on most orders
- "INFO FAX" with 24 hour information
- Toll free 800 numbers for both voice and FAX

See our complete
 catalog and product
 descriptions on our
 web site at
www.com-spec.com

Circle (3) on Fast Fact Card



COMMUNICATIONS SPECIALISTS, INC.

426 WEST TAFT AVENUE • ORANGE, CA 92665-4296

(714) 998-3021 • FAX (714) 974-3420

ENTIRE U.S.A. (800) 854-0547 • FAX (800) 850-0547



Outside USA or Canada: Jescorp Internacional, S.O., 17th Avenue, San Mateo, CA 94402 USA • Phone (650) 574-1421 • FAX (650) 574-5257



Your communications should move as fast.

Introducing the newest in a line of remarkable booster amplifiers – The Intelligent Booster Amplifier (IBA). Designed to operate on moving platforms, the IBA was originally designed to operate on high-speed rail systems. With applications also extending to subway systems and other forms of rail transportation, the AeroComm IBA is a cost-effective method for improving coverage on the railways without building additional sites.

Unlike air travel, rail systems afford the professional traveler the opportunity to use personal wireless services. With the AeroComm IBA, internet on the go, teleconferencing at 150 mph, and all uses of your wireless phone are now possible. Leading technologies such as our Dynamic Scanning Receiver and Global Positioning System provide

constant coverage and high-quality calls along the desired path. As an added benefit, an external computer allows you to program coordinates at known trouble spots – or shut off the



Intelligent Booster Amplifier

IBA completely in good coverage areas.

Call us at the number below for information on how the Intelligent Booster Amplifier can meet your customers' communications needs.



A Wireless Systems Company

Circle (2) on Fast Fact Card